*for . . .*

engineers and contractors controlling the design, specification, installation and maintenance of heating, ventilating and air conditioning.


# HEATING AND VENTILATING

*The Air Conditioning Monthly*



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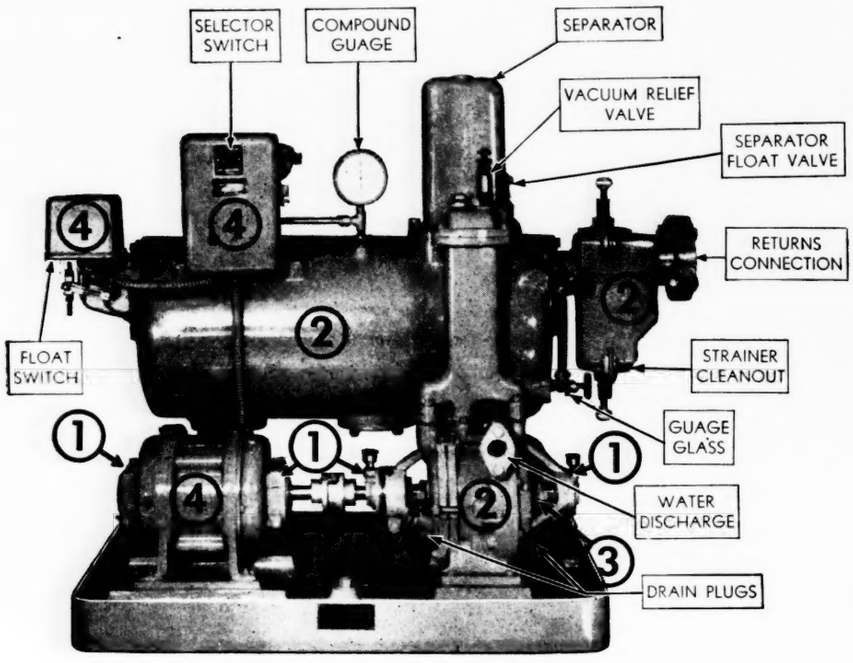
**THIS MONTH'S COVER**

Each day brings new developments in the status of food dehydration—the latest being that the demand, since the African campaign, is now almost unlimited for dried foods, due largely to the great saving in space feature. The cover photo (by Acme) shows a meal for two, consisting of compressed dehydrated soup, egg, meat, vegetables, chocolate pudding and coffee. See page 35—What the Air Conditioning Engineer Should Know About Food Dehydration.


MEMBER
Audit Bureau of Circulation
Associated Business Papers

# How to keep your Jennings Heating Pumps in First Class operating condition for Duration...




## YOUR JENNINGS RETURN LINE VACUUM HEATING PUMPS

are an important part of plant or building equipment. They cannot be easily replaced and must last for a long time. Jennings Pumps are designed for long life, and have extra capacity which will count when it may be difficult to maintain lines and equipment free from leaks, but to give full service they must have proper care.

Now that these pumps have been in service all winter on the heating system, they should have a thorough inspection. Special attention should be given to the bearings, as no wearing contact occurs in a Jennings Pump as long as the ball bearings are properly maintained.

In most cases Jennings Pumps will require only the check-up we have recommended. If additional adjustments or repairs are found to be necessary, they should be undertaken at once. Do not wait until both time and materials are running short. Nash Service Branches are established throughout the United States. If you do not know the address of the one nearest to you, write directly to this office. Nash Service is yours to command, NOW.

## SERVICE POINTERS

**1** LUBRICATE PUMP AND MOTOR BEARINGS . . . Check bearings for end play, or radial play, and be sure they contain no grit, or foreign matter. If found to be clean and in good condition, fill with proper non-acid grease lubricant. If motor has oil lubricated bearings, flush out with fresh oil, and refill.

**2** CLEAN STRAINER AND STRAINER SCREEN . . . Clean strainer well and strainer screen. If screen is found to be worn, and has passed foreign matter, thoroughly flush both receiving tank and pump casing. Drain plugs are conveniently located . . . Damaged screen should be repaired or replaced at once.

**3** RENEW STUFFING BOX PACKING . . . Remove old packing and clean stuffing box. Fill with new loose-woven graphite-impregnated stuffing box packing, in individual rings. Be sure joints are staggered, and that ends butt properly without over-lapping. Do not finally tighten gland until pump is again in operation.

**4** HAVE MOTOR AND CONTROL INSPECTED . . . Have an experienced electrical service man go carefully over motor and control. Follow his recommendations and if repairs or replacements are indicated, have the work done immediately.

**5** CHECK OPERATOR'S INSTRUCTION BOOK . . . If operating instructions originally furnished with the pumps have been lost, write to us at once for a new copy for each pump. BE SURE TO FURNISH US THE TEST NUMBER OF EACH PUMP, as stamped on the pump name plate.

**6** IF PUMPS REQUIRE REPAIRS . . . and you do not know the address of our nearest Service Branch, notify us at once, and we will have our Service Engineer get in touch with you without delay . . . There are well equipped Nash Service Branches in most principal cities, ready to give you every possible help.

# NASH ENGINEERING COMPANY

**254 S. WILSON ROAD • SOUTH NORWALK, CONN.**

*A view in the laboratories of the Washburne Trade School where the experimental work described by the author was carried on.*

# Reducing Weights and Costs of Radiator Heating Systems

By A. J. SANDER

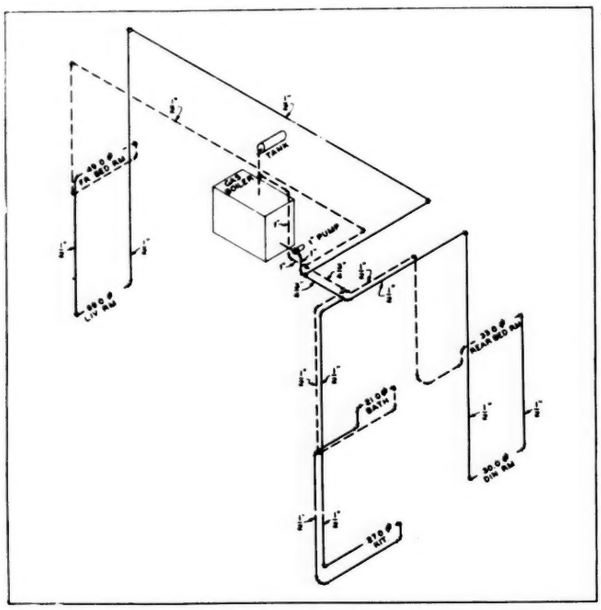
In Charge of Engineering, Chicago
Steam Fitters' Association, Chicago

FOR the past four years the trend in building has been toward the smaller and more compact low-cost homes. This trend has made it more than ever necessary to revise heating system design with the dual objective of reducing sizes of equipment as well as over-all installation cost. An analysis of costs of radiator heating systems makes it apparent at once that significant reductions in the cost of the completed job to the house owner would have to be affected in one or more of the following items: radiation, boiler and controls, overhead and profit, and labor.

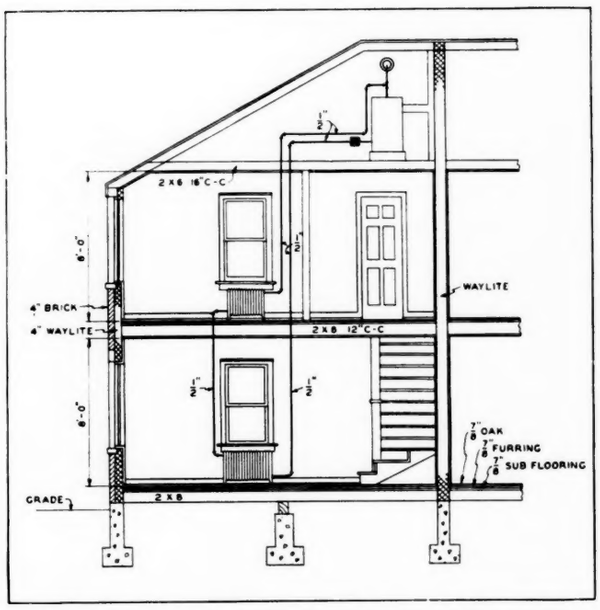
In regard to size, or weight, the heating industry had begun a trend toward weight and size reduction long before the WPB restrictions on critical materials; heating equipment has for a fairly long time been available in light and more compact units. Other factors operated to accentuate this trend: insulation and storm windows save 20% in heating plant weight; the advent of the slim-tube radiator (40% smaller than its predecessor) sharply reduced the weight of the system; convectors which can be neatly tucked into the walls are so designed that the maximum amount of heating surface is obtained with a minimum of material; forced hot water circulation made it possible to use pipe of much smaller diameter and to use single main systems instead of double mains; finally, the direct installation of a water heater inside the boiler eliminated the outer shell of the water heater. All of these technical trends combined to reduce material and labor costs, with the result that it is possible to reduce the first installation cost, as well as total operating yearly cost, well below those prevailing a few years ago. Generally speaking, however, full advantage has never been taken of all these developments in combination.

The basementless low-cost ($4000) house presented a challenge to the heating industry for the development of a low cost radiator heating system. This challenge was met in Chicago where 300 out of 400 houses in one sub-division are being heated by a hot water system with boilers placed in the utility room on the same floor as the rest of the building. Circulation of the water is by a mechanically forced circulating pump, located in the utility room. The system has a single main which runs approximately to the center of the building. At the end of this main was attached a prefabricated manifold heater with ten openings, connected by copper tubing run directly to the radiators. Similarly, the return lines from the radiators entered a second manifold which is attached to a return main leading to the boiler. The copper tubing was attached to the radiators by use of sweated fitting connections, while the manifold was designed for sweating the tubing direct to it. The resulting layout is economical in its use of pipe, giving a saving in both metal and labor.

While some of the houses were all on one floor, others were of the row-type, with a utility room, a living room and dining room, and kitchen on the



*Isometric drawing showing the layout of the radiator heating system with the gas boiler in the attic.*



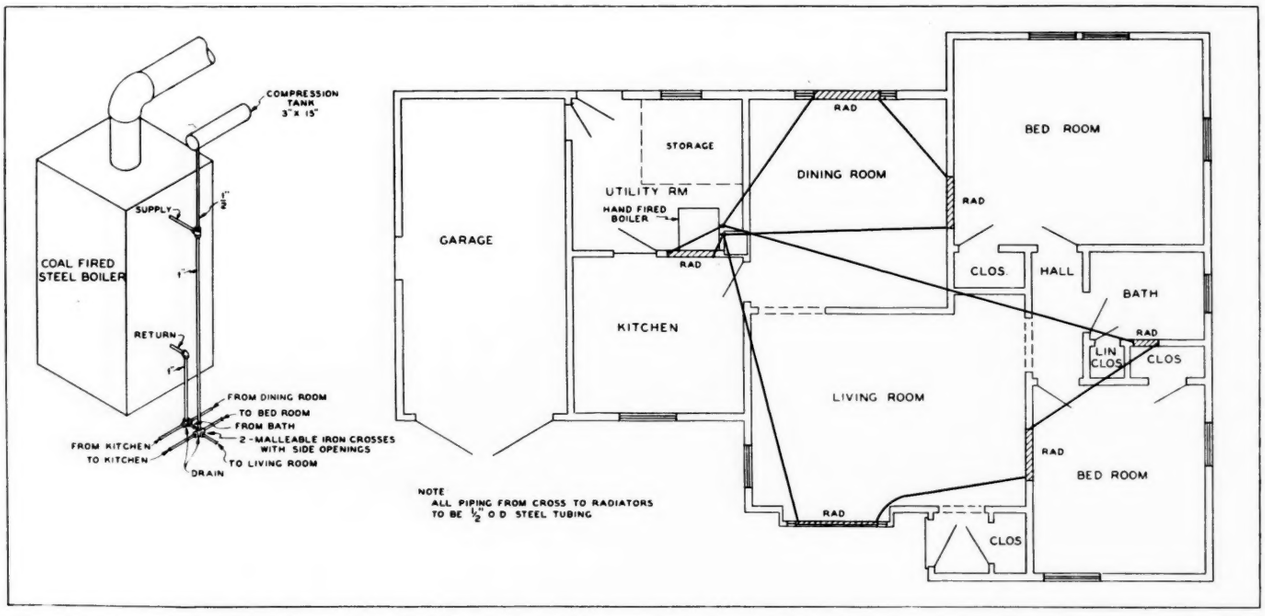

*Section of house with the boiler-in-attic system showing arrangement of risers.*

first floor; two bedrooms and a bath on the second floor. There is no basement.

It was decided to experiment at Washburne Trade School with the idea of placing the boiler in the attic. By using an attic-type system we could eliminate the utility room entirely. This, with other partition changes, would make a savings to the owner; it would also increase the storage space in this type of house. Such a method, however, involved use of gas fuel. Although we did not know what size pipes or what size circulator to use, there was no doubt in our minds that this upside-down job would work.

An exact duplicate of an actual system for one of the $4000 houses was installed in Washburne's Thermal Research Laboratory. This installation of an experimental, basementless, forced flow hot water type heating system was completed by the steam fitting apprentices for their instructional use as well as for research work. This job was exact insofar as pipe sizes, length of run, and the radiator sizes to be used on typical war worker houses.

Since there were no authoritative data on design with attic boilers, the first layout was set up with ¾ in. drop risers and a one-pipe system with a 1 in. circulating pump. Two mechanical booster pumps were used in this system, valved so that one may be used to reverse the flow of water. The supply was taken off at what is normally the return connection of the boiler. The supply riser drops




*The drawing at the left shows the details of the piping around the boiler when the coal-fired unit was used. The drawing at the right shows the piping on the first floor when employing the coal-fired system.*

directly to the first floor into the bottom of a radiator which has no valves or air vents. The outlet is run from the top of this radiator into the bottom of the second floor radiator, thence out of the top of the second floor radiator up to the top of the boiler, with the expansion tank at the high point.

An additional point of interest in the development of this system is that one of the builders of the houses estimated that $45 could be saved by the elimination of a masonry chimney and substituting a length of vitrolite as a chimney; this would also do away with the possibility of a wrong-sized chimney being constructed.

At the top of the loop on the return to the boiler we installed a 2 in. tee. In this tee was placed an automatic low water cut-off. This is used to cut off the gas supply when the water becomes low in the system due to the release of water by the automatic relief valve if the pressure should become excessive. In the test set-up there were no valves or other means to balance the job.

The tests at Washburne were successful in that it was found that we could reduce the pipe sizes so that by one ½ in. drop riser we could carry all the radiation necessary for the two radiators.

After the system operated successfully and we had so developed it that the cost was competitive it was, nevertheless, still too heavy and out of line with WPB's critical list. The system using cast iron radiators, cast iron boiler, and steel pipe weighed 1500 lb, approximately.

Further changes, however, brought encouraging results. Use of a convector radiator brought the job down in weight to 1240 lb. It was still too heavy. Then a conventional steel convector as used on high-pressure work was tried, and this brought the weight to 1056 lb. Then a convector was used which involves steel pipe and which we could employ as part of the main on the job and eliminate two drop risers; in other words, the radiator or convector ran around the perimeter of the room. This reduced the weight of the system to 936 lb. We thought that we had done pretty well; Washington did not think so.

About this time came the curtailment of the use of gas. This system could have used oil by placing a tank in the attic, but it did not seem desirable to have oil stored overhead, so we did not further consider heating with oil. This brought us back to a utility room on the first floor.

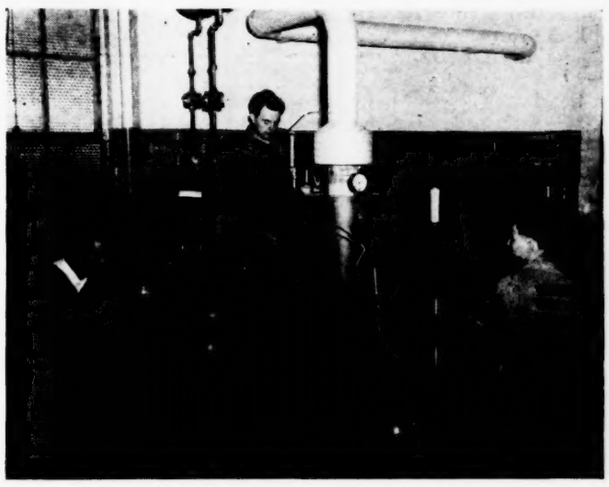
A suitable coal-fired boiler was sought. We found a steel, hand-fired boiler, water-tube type, which weighed 315 lb. To make the boiler of lighter weight metal than was required by the A.S.M.E. Boiler Code, the system was designed to use an open expansion tank so as to use low pressures. This eliminated the expensive pressure release valve without reducing the safety factor.

The expansion tank was installed directly above the boiler at the ceiling. The boiler was equipped with a sensitive damper regulator which would override above 10F. A reverse aquastat was connected to a 1¼ in. high velocity pump. Whenever the pump would cut in, due to the action of the reverse type aquastat, it would control the temperature accurately. The boiler was then made of a lighter weight metal, i.e., 14 gauge. The boiler then weighed 197 lb, or a savings of 118 lb of metal.

Now we had a low weight boiler, but the radiation was still too heavy. Next tried was a steel convector core which could be installed in a recess, lined, and built in by the carpenter with only a steel metal front panel. This steel convector weighed approximately ¾ lb per square foot of radiation, and was equipped with adaptor fittings which would allow us to sweat copper tubing or braze steel tubing directly to it. The tubing to the convectors is run between the sub-floor and the finished floor. Last year we used copper tubing, but as we had heard that this tubing would be restricted, we had experimented and successfully used ½ in. O.D. steel tubing to connect the convectors. As the copper convectors were restricted we also stopped using the steel tubing. With copper or steel tubing we found that we could connect two convectors in a series. Further experiments made us positive that we could connect three convectors in a series, thus eliminating more weight. As long as the total output of the three convectors in series is not over 115 sq ft with not more than 100 ft of tubing, it was found that the temperature drop in some cases would be between 7½ to 10F after the third convector.

This system with the boiler, tubing, convectors and instantaneous water heater weighed 457 lb. No trouble was anticipated with this light weight metal due to the fact that the boiler is in operation summer and winter so that corrosion is at a minimum.

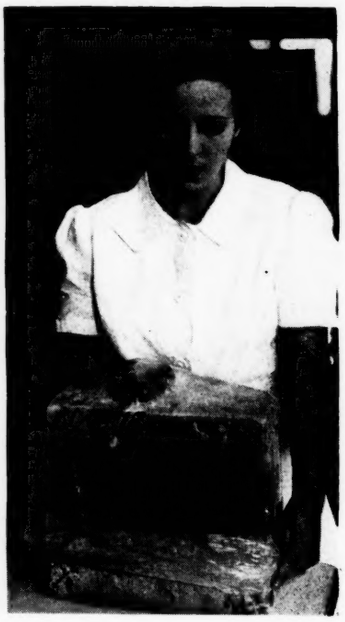
Little reduction in weights of systems has been made recently. We are not certain what the future holds, or whether we have the final answer. We do know, though, that we started out with a weight of 1500 lb for the system and now we have reduced it to less than 500 lb. While it may not be the system of the future, at least it is a step in the right direction for the conservation of metal.



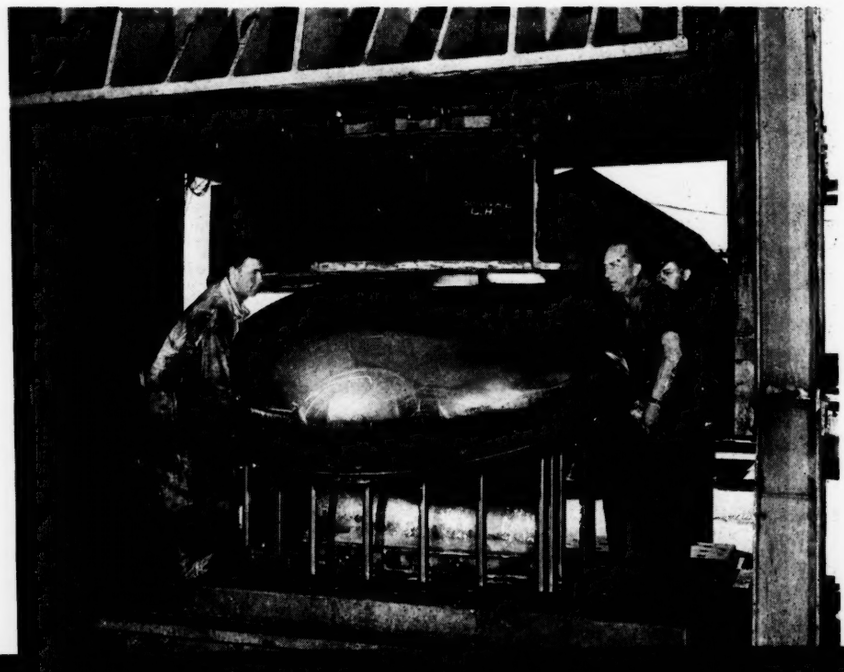
*Boiler under test at the Washburne Trade School.*

# PICTURE PARAGRAPHS

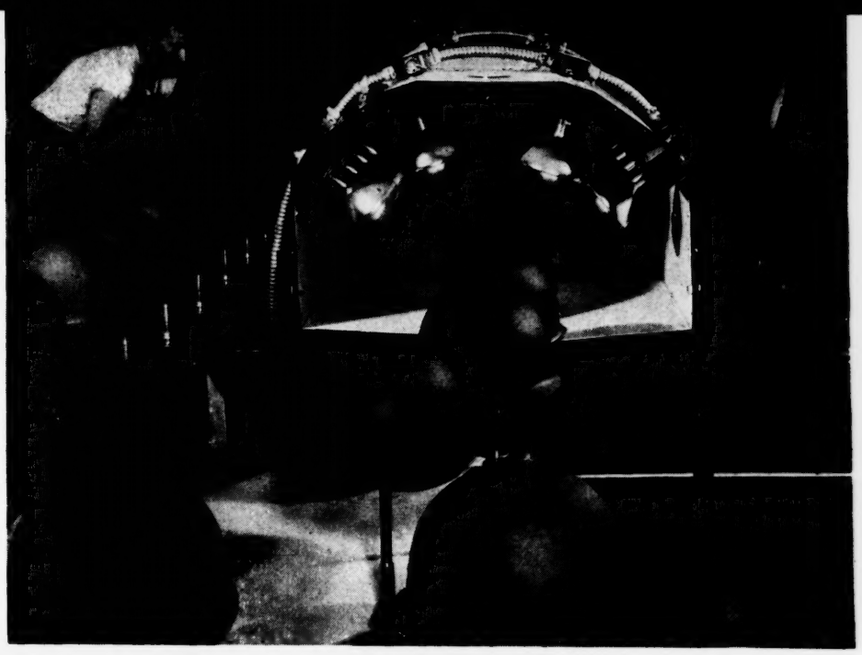
**FROZEN EGGS.** The egg-breaking business is reaching a new high this year, with an estimated 3,430,000,000 eggs to be opened and frozen. Many of them are subsequently dried and shipped in lend-lease to supply our allies abroad with high nutritional values per unit of weight. Others go to bakeries, noodle makers and other food manufacturers in this country. Above, girls crack the fresh, candled eggs against a breaking bar and separate them by means of a hinged spoon and collar gadget. The yolk is held in the spoon while the collar is swung down over it to strip off the white. . . .



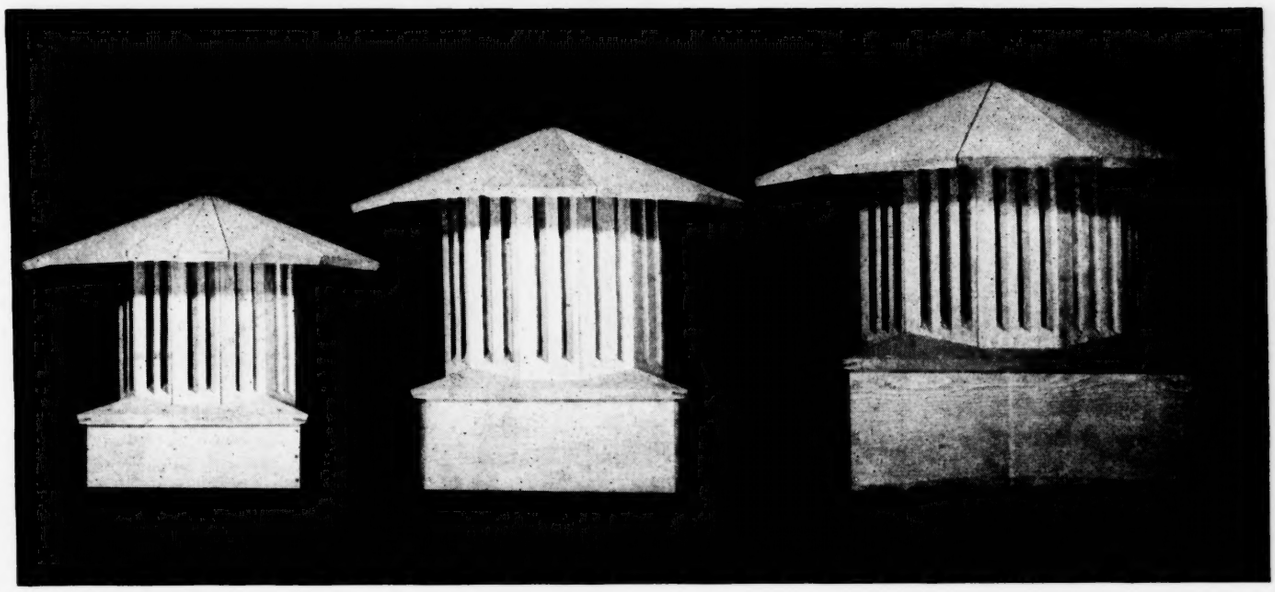
. . . Most of the egg-freezing is done during the big laying season in the spring and summer, preserving July freshness for January tables. At the left the liquid eggs, made smooth and homogeneous by slow churning, flow into a water-proof cellophane bag, developed by DuPont. This is supported by a cardboard carton. Every cellophane-lined container saves 2 lb of metal, the weight of the metal formerly used. At the right is what appears to be a 30 lb block of ice wrapped in cellophane, but in reality is 24 dozen eggs, frozen at 0F to —15F. The cellophane is being stripped off preparatory to defrosting or for drying.



20,000 COWL VENTILATORS for Liberty ships are being made by Weber Showcase and Fixture Co., Inc., Los Angeles. View at right shows 13 ton press with dies of meehanite iron stamping out half of a ventilator.



**ARMY HELMETS** of freshly-painted Micarta are here being dried by infra-red lamps which have speeded drying about 1000% and reduced the dryer installation cost from $2500 to $600, according to H. C. Guhl, Micarta development supervisor of Westinghouse Electric and Manufacturing Company. The oven method of drying would have required a tunnel-shaped unit 225 ft. long, and the drying time was estimated to be 15 min.; the infra-red dryer installed is 19 ft. long and dries the helmets in 95 seconds.



**WOOD VENTILATORS** ease the metal shortage. Among numerous wood items produced by Weyerhauser's General Timber Service, Inc., are these louvered wood ventilators made in three sizes for farm buildings. Air flow is regulated by adjustable sleeves, while the louvers are arranged to aid a rotating motion of the air column. Device can be made by woodworking plant with precision jigs.

**VAN DYKE** production was speeded 350% and the number of rejected prints reduced from 25% to zero, a saving of approximately $300 per month, by use of 12 infra-red drying lamps, according to J. J. Deller, supervisor of the reproduction and blue print departments at the Westinghouse East Pittsburgh works. The increased use of Van Dykes to meet wartime production schedules resulted in a careful time study analysis of the printing process. Biggest time losers were found in print drying and in repeat jobs due to rejects from distortion by squeezing. Infra-red drying eliminates the distortion.

# Are You Planning to Sell Steam to a Neighbor Plant?

By ROBERT H. EMERICK†

Lieutenant-Commander, U. S. Navy

IF you operate a boiler plant and have not as yet been asked to sell your neighbor steam, your time is probably coming. This is particularly likely if your neighbor is expanding for war work.

The business side of accommodating this neighbor may invoke some legal questions, such as franchises and easements, contracts and liabilities. It certainly involves the rate making problem, one likely to have most unhappy consequences if the solution is far from correct.

## Franchises

Consider the franchise situation first. The selling of steam to a neighbor may, or may not, put the seller in the public utility business, depending on the state and local point of view. Possibly the serving of one customer is not considered locally as a public utility enterprise, but the serving of two or three might be. Again, the number of customers may have no significance, *provided* that the service line does not cross a public right of way. These points should be clarified before a contract is executed.

Franchises cost money, and the cost is not always offset by the intrinsic and strategic advantages so obtained. In other words, the cost of the franchise (if necessary) to sell steam to your neighbor may be simply beyond recovery during the expected life of the contract. Of course, a franchise granted for a long period, say 99 years, has the possibility of becoming an ultimate gold mine, especially if the district prospers, but a case of this sort is properly termed an investment or, perhaps, a gamble, and as such cannot be charged wholly against the business immediately at hand. If a franchise is required, but already held by someone else, the matter becomes complicated, to say nothing of expensive. At times like these the gold mine shows possibilities of paying off, but not to the seller of steam. There is only one thing more unlucky than finding a needed franchise in the hands of someone else, and that is to find it there after the service begins. The consequences can be quite distressing.

Customers who are also tenants of the seller, and can be served by steam lines that never leave the seller's property, are not likely to involve either franchise or public utility complications. However, all local regulations of safety and practice should be observed as common prudence.

## Easements

Suppose the steam line does not cross a public thoroughfare but must traverse property owned by someone other than the seller or buyer. What then? An easement is commonly now in order, an easement being a legal instrument under which the owner of the traversed property permits the steam line to cross the property in question for a stipulated period of time, either with or without charge for the privilege. In securing an easement care should be taken that the life of the proposed project is long enough to allow the business to pay off the service line construction costs.

## Rates

Assuming that no alteration of the plant is necessary, and that existing personnel can carry the extra load, the only out-of-pocket expense to the seller is the construction cost of the service extension, plus the operating costs made up of such items as fuel, water and billing, and the rate can be shaped accordingly.

For example, suppose that the new customer will take 10,000,000 lb of steam annually; second, that the cost of the service extension is $5000; third, that coal costs $5 per ton delivered; fourth, that water rates are 50 cents per thousand cubic feet; and fifth, that the boilers are generating steam at 100 lb per sq in. gauge pressure, saturated, from feed water at 160F and with an overall boiler efficiency of 80%. With these figures at hand, it is possible to convert these data into dollars as follows:

Ten million pounds of steam is equivalent to approximately 160,000 cubic feet of water, and to evaporate this water to steam at 100 lb pressure and with 80% efficiency, will require 934,000 lb of 13,500 Btu per lb coal. The cost of the water totals $80 per year and the fuel bill amounts to $2335. To these items of outlay must be added (a) cost of meter reading and billing; (b) maintenance of the service line and meters; (c) annual charges against the service line construction cost; (d) insurance; (e) franchise and easement costs, if any; and (f) all other out-of-pocket expenses. Assume the value of (a) at $60, or $5 per month; (b) at $50, or 1% of a $5000 service investment; (c) at $1150, based on an average 3% interest and 5-year write-off; (d) at

†Formerly with Philadelphia Steam Co., Day and Zimmerman, and Phoenix Engineering Corp. Statements made in this article are purely those of the author and are not official statements of the U. S. Navy.

$100; (e) nil, although it might be anything; (f) $50 miscellaneous; and the total cost to the seller for 10,000,000 lbs. of steam in one year becomes $3825. This is equivalent to a unit cost of 38¼ cents per thousand pounds. Above this the profits begin.

The foregoing figures indicate what enters into the cost of steam when the cost is of an increment nature. Additional labor, if needed, will add to this cost as an operating item, and additional plant will affect the rate in the same manner that the service line affects it, that is, in interest and write-off charges over a period of years.

The item of fuel, in any rate, comes in for a little special attention. Coal costing $5 per ton this year, will perhaps reach the bins only on payment of, say, $7 next year, or the price may drop to $4. In either event, an adjustment of the rate is in order. Public utility companies generally handle the situation by writing a fuel clause into their contracts. This clause provides an automatic increase in rate if the fuel cost exceeds a stipulated figure and effects a decrease in rate if the price turn is downward.

A rate calculated as illustrated is designed primarily for application to steam sales that are metered, but this type of rate is not the only rate possible. Among public utility companies the demand rate is in wide favor, while other forms of charge, based on building volume, or on square feet of connected radiation, or even on a flat monthly or annual charge, are met with often enough to invite attention.

### Demand Rates

The demand rate in theory is quite simple. It grows from the premise that the total cost of steam service is composed of two principal parts; first, annual charges on plant investment, and second, operating costs. Every plant has a maximum output in pounds of steam per hour, and the total annual charges, when divided by this maximum output, produces a pro rata charge per thousand pounds of the plant's hourly output. According to the theory, every customer should assume his share of the pro rata charges, his share being dictated by the portion of the plant generating capacity which must be available at all times to meet his particular needs.

In practice, this pro rata charge is usualy collected in a series of monthly payments, and the amount for which each customer is liable is determined by a special demand meter, which records the customer's withdrawal of steam from the mains during each separate hour that the service is on. The demand charge, so determined must be paid by the customer regardless of the rise and fall of his overall steam consumption, since the plant must be ready at all times, whether the customer uses it or not.

This demand, or ready-to-serve charge, as it is sometimes called, is a reasonable component of the rate when the plant has been constructed for the sole purpose of selling steam at a profit. It does not appear to be a suitable rate when the customer list is composed of one or two neighbors, who would certainly object to paying charges on a plant that was built for, and performing, prior duties.

### Volume Rates

The volume rate is based on the volume or cubage of the building heated. It is applied most frequently for heating customers only, as, obviously, it cannot be used to bill a process load. It requires considerable knowledge of average and maximum weather conditions to be safely calculated. For example HEATING AND VENTILATING *Reference Data Sheets* 209-212, inclusive, which cover the degree-days for most of our key cities, show New York to have had a seasonal minimum of 4857 degree-days and a seasonal maximum of 5741 degree-days, over the five heating seasons of 1936-1941. A variation like this is enough to cause a minor financial disaster if the rate has not been shaped to meet it.

A volume rate generally presupposes a more or less fixed relationship between temperature and volume. The experience of this writer, over several years of observation and analysis, discloses no relationship of sufficient uniformity to support a simple rate. To illustrate, the record of steam requirements for eight modern office buildings in the city of Philadelphia during a single year shows a minimum consumption of 0.445 lb of steam per cu ft of volume, and a maximum of 2.051 lb per cu ft, a range of nearly 5 to 1.

Most of the uncertainties characteristic of the volume rate can be said to apply also to a rate based on connected square feet of radiation. Theoretically, a square foot of radiation, when filled with steam at 212F and surrounded by still air of 70F will release 250 Btu per hr. Actually this rate of heat emission is affected materially by drafts, the kind of paint on the radiator, air pockets in the radiator, drainage or lack of drainage of the condensate, and the presence, absence, or operating condition of the thermostatic traps. In short, the area of connected radiation is a pointer toward, but not a measure of, the actual steam condensed.

### Need for Meters

In the opinion of this writer, both volume and connected radiation rates are unsatisfactory sub-

stitutes for the steam meter. Such rates may function quite well as a kind of supplementary charge, or if shaped along the line of a demand charge, but they appear altogether too subject to criticism to be recommended for the whole rate. On the other hand, meters are not expensive, particularly if a condensate type can be used, and a meter will justify its use many times as a preventive of friction between the seller and the customer. A meter likewise allows the making of a block rate. With the block rate the first block of steam per month, say the first 100,000 lb, costs so much per 1000 lb; the next 100,000 lb, something less, and so on. Thus the block rate satisfies the natural desire of the customer for a reduction in cost when he buys in wholesale quantities.

A recapitulation of rate schedules shows that one has a choice among the following established possibilities:

(a) A flat charge per 1000 lb of steam delivered or used, and measured by a condensate or steam flow meter;

(b) A flat charge per cubic foot of the customer's building volume;

(c) A flat charge per square foot of customer's connected radiation;

(d) A two-part rate consisting of a demand charge based on measured demand (or on building volume or on the connected radiation) and an additional charge based on the customer's metered steam consumption;

(e) A consideration rate, under which for an agreed sum or consideration paid by the customer to the seller monthly, or perhaps as a lump sum, the customer is allowed to take steam from the seller's mains as necessary. This rate is met with frequently in manufacturing loft buildings, where the numerous customers draw steam from the building risers as these risers traverse the various floors.

Any one of these rates may be chosen by the seller of steam, and for each there exists ample precedent. The one precaution advisable is to be sure that the choice of rate covers the situation adequately. The proper rate will stand between satisfaction and dissatisfaction, and between profit and loss.

### Written Contracts

No agreement for the buying and selling of steam should be verbal in any part. Dissatisfactions, suspicions, and even enmities can arise from a customer's "You said so," especially when followed by the seller's "I did not." The contract should include a clear statement of the rates and terms of payment, responsibilities of the seller, responsibilities of the buyer, a disclaimer or limitation of damage statement effective in the event of a service failure, and certainly the length of time the contract is to endure. Also, there should be set down exactly what the seller is to provide in the way of service connections, as sometimes considerable piping alteration on the customer's premises will be needed and it is well to have each party to the contract understand who is responsible for what. Public utility contracts provide valuable information on the essentials of such a document, and time taken to observe how these experts make their agreements may help substantially to safeguard the new business. When in doubt, consult an attorney.

To summarize, the business side of selling steam involves (a) legal questions, (b) economic questions, (c) rate problems, and (d) contract precautions. Both the seller and the customer are intimately concerned in seeing that these problems are solved satisfactorily if the business is to become a success.

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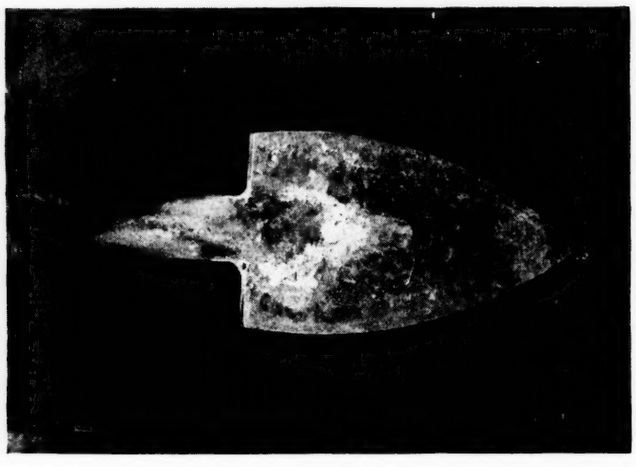
# Old Iron Makes Tool for Removing Lagging



Many homemade devices in the form of pointed bars, picks and such arrangements are made and used to break up and push off old lagging. When it is necessary to work on a ladder or scaffolding some of them are unhandy and even unsafe to use. They are generally either too heavy or too light, too short or too long. A very practical and easily constructed affair is shown above. Saw a slot in the end of an old piece of 1 in. pipe, the pipe of a length which can be used easily and conveniently in a standing position. Drive the sole plate of a discarded electric flat iron between the forked end of the pipe, pound the fork flat to the plate and spot weld firmly on as shown. This tool is just light enough and just heavy enough for old lagging, and is handy and convenient to use.

# Estimating Quantities of Fuel Oil Wasted

IN these days of careful conservation of scarce materials, efficient operation of boilers and furnaces is highly desirable. The accompanying chart is designed to show graphically (and emphatically) the amount of waste resulting from inefficient operation.

The chart assumes an objective efficiency of 80%, and all calculations are based on a comparison with that figure.

As an example of the use of the chart, assume a boiler operating with 6.5% carbon dioxide in the flue gas and a stack temperature of 525F. The intersection of lines from these points, as shown on the chart, indicates a "poor" efficiency of about 68% and an oil waste of 14 gal out of each 100 gal used, as compared with no waste if the efficiency is 80%.

The chart was designed by O. M. Elliott and W. S. Hobbs of the Engineering Div., Manufacturing Dept., Sun Oil Co., Philadelphia, Pennsylvania, and appears on these pages through their and their company's cooperation.

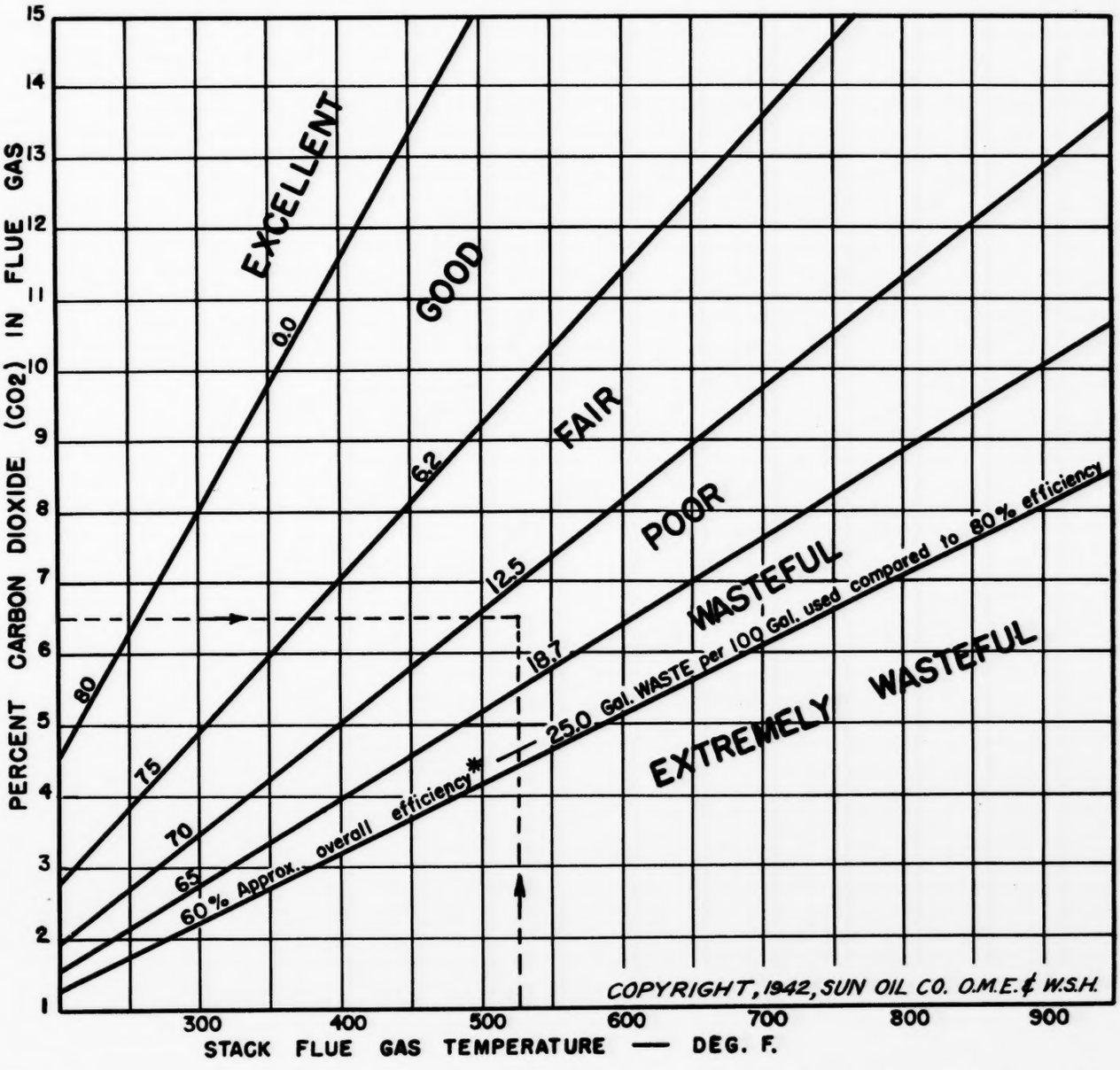



*Chart for estimating fuel oil wasted by inefficient boilers and furnaces as compared with clean fires and a resulting 80% efficiency. * indicates that a 7% hydrogen moisture loss and a 5% radiation and unaccounted-for loss has been included.*

# Moisture Removal in Room Coolers

By A. H. EBERHART

Air Conditioning Engineer, Westinghouse Electric & Manufacturing Company, East Springfield, Mass.

*Fig. 1. A typical 1/2 hp room cooling unit mounted in an office window.*

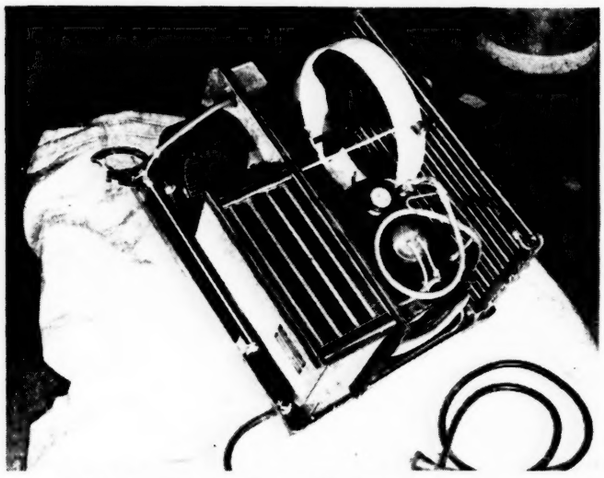


*Fig. 2. The cooling unit shown in Fig. 1.*

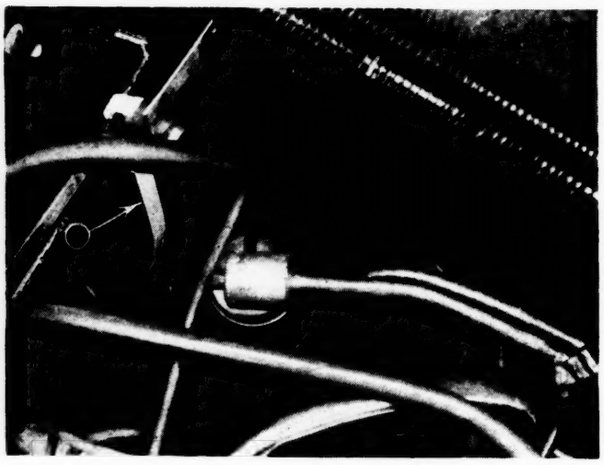


*Fig. 3. The atomizer strip in place at the outlet of a centrifugal fan. No. 1 arrow indicates strip.*

ONE of the major problems in the design of self-contained room coolers, a typical example of which is shown in Fig. 1, is the proper elimination of condensate, or the moisture "condensed" out of the air as it comes in contact with the cold surfaces of the evaporator. The amount of moisture taken from the room air is determined by the particular design of the room cooler and by the temperature and humidity conditions in the room.

A room cooler operating in the desert or in other exceptionally dry localities may remove no moisture from the room air. The same unit operating in a humid locality may utilize approximately one-half of its cooling capacity in extracting moisture from the room air. Under these conditions a ½ hp room cooler would remove moisture from the room air at the rate of approximately three pints per hour. At the same time the air passing through the unit is cooled to produce a lower temperature in the room.

Room coolers having water cooled condensers depend upon drain connections for the removal of condensate, since the drain that carries away the waste cooling water is convenient for draining the condensate. Modern room coolers, however, having air-cooled condensers, have no drain connections. Instead the condensate is automatically evaporated and discharged to the outside. This usually is accomplished by a combination of devices that includes a bottom pan for holding the condensate, the pan frequently serving as a base that holds the entire refrigerating mechanism. Often a large spirally-wound coil of tubing carrying hot discharge gas is located on the bottom of the pan to heat the condensate and facilitate evaporation.

For low humidity conditions the combination of a large pan with a spiral coil of discharge tubing is adequate. Many localities, however, have humidities so high that it is necessary to resort to other means, that of spraying the condensate onto the finned air-cooled condenser coil. If a propeller type fan is used it is possible to spray condensate onto the refrigerant condenser surface by having the fan blades dip into the water in the drain pan. Figure 2 shows such a unit. The propeller type condenser fan and the centrifugal type evaporator fan are directly connected to a single fan motor. The large black shell contains a hermetically sealed compressor.

Units having centrifugal type condenser fans cannot utilize this method of moisture disposal as the fan wheels must be located above the water level.

Fortunately, however, these fans are capable of generating very high air velocities making possible a very simple solution to the problem.

A flat strip of metal is fastened vertically to one of the studs that holds the condenser coil so that one end dips into the water in the path of the air leaving the fan housing. Water climbs up the strip on the *leeward* side and is blown in a fine spray to the finned condenser coils where it immediately evaporates. The proper size and location for the atomizer strip were determined by experimentation. The length of the strip is such that it is held in a curved position by compression against the lower edge of the fan housing, as shown by Figs. 3 and 4. Air passing the atomizer strip placed at an acute angle creates a partial vacuum in the region adjacent the leeward side of the strip. Water drawn into the partial vacuum travels upward for a considerable distance and even to the very top of the strip before finally being carried away to be evaporated either in the air stream or on the condenser surface.

Utilizing the condensate for evaporation in the condenser air stream greatly improves the efficiencies of air-cooled room coolers in addition to making them more practical from an installation standpoint. Laboratory tests have shown that evaporating the condensate on the condenser surface increases the efficiency by lowering the discharge pressure by five to ten pounds per square inch on units operating at standard conditions when the latent load is approximately one-fourth of the total load. An even greater increase in efficiency is obtained at very high humidity conditions by properly evaporating the condensate in the condenser air stream.

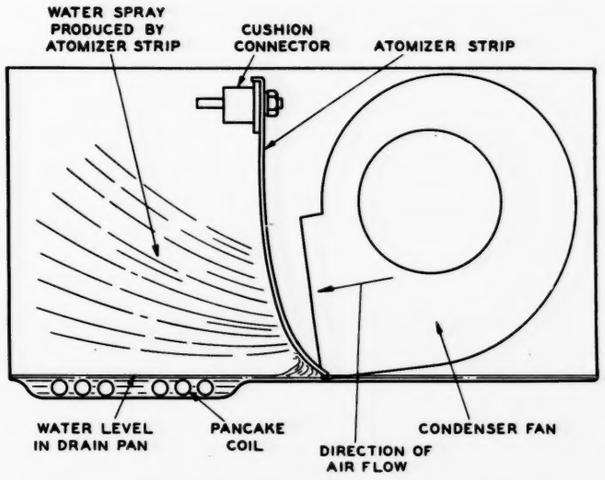



*Fig. 4. How the metal atomizes the condensate.*

# How Much is a Barrel?

After having made a study over a period of years of the question How Much Is a Barrel, I have come to the conclusion that nobody knows. No value for a barrel has ever been adopted by Congress in the United States and it appears that the same is true in Canada. I am informed that in the Internal Revenue Bureau and in the Custom Service every barrel must be gaged because of the fact that there is no fixed standard.

The barrel varies all the way from 30 to 42 gal in the United States. One unit as given is 31½ gal or 4.211 cu ft. The British barrel of wine and brandy is given as 31½ gal and also 36 gal. Take your choice. Personally I prefer the 36 gal size provided I can obtain it at the same price. Another unit is given as 31 gal—a U. S. measure.

Still another unit, as used all over the world by the Standard Oil Co. in the measurement of refined oil, is 42 gal per bbl. That unit has been adopted by all other companies in the United States and it now applies to crude and other oils as well as refined oil. A barrel of flour in the U. S. is equivalent to 3 bushels, or 3.75 cu ft.

Another unit, the "dry" barrel, in the U. S., is gigantic in size—21½ bushels or 26.756 cu ft. It is reported from one source that the standard U. S. barrel for dry commodities such as fruits and vegetables must contain 7,056 cu in. or 4.08 cu ft.

A beer barrel is supposed to contain 36 beer gallons of 282 cu in. per gallon; but according to recent reports this is not always true and if a beer barrel is as much as 2½ gallons short it gets by. To complicate matters still further, Pennsylvania has a measure of its own, namely, 32 gal per barrel.

Beef and pork are sometimes sold by the barrel, and when they are a barrel is supposed to contain 200 lb. In Spain one barrel of raisins weighs 100 lb. In Malta a customs barrel contain 11.4 gallons.

Just how all of these various sizes of barrels were arrived at would make interesting reading, I daresay, but I am unable to furnish the details. I can say, however, that the 42-gal oil barrel was the result of many years of confusion. Thus in the early days when there was no standard the barrels ranged in capacity all the way from 40 to 55 gallons. Finally the 40-gallon barrel became most popular, but it was common practice to add 2 gallons for tare or estimated loss during handling, and that resulted in the present 42-gallon size.

Finally, in the U. S. it is customary to consider a barrel of grease as weighing 315 lb; asphalt, 364 lb; petrolatum, 300 lb; bitumen, 364 lb; and wax, 280 lb.—*W. F. Schaphorst*

# Summer of 1942 Cooler than '41, Degree-Hour Data Show

Since the number of variables which affect the summer air conditioning load is high and since the dry-bulb temperature of the outside air is of much less importance among the other variables than it is in connection with winter heating, it is doubtful if any one single factor can be used to show load proportionality for different types of buildings in the summer as it can in winter with the degree day.

However, where there is little internal load, either sensible or latent, such as in residences, some such simple proportionality may exist. Research indicates that the load unit for residences for summer may be the summer degree hour above 85F.

*Maximum, minimum, and average seasonal totals of summer degree-hours are included in both tubular and map form in the Air-Conditioning Engineers' Atlas, by Strock and Hotchkiss. The Industrial Press, 148 Lafayette St., New York. Price, $2.

The figures below show the number of degree-hours for the past summer for a number of cities.* To obtain them, 85 was subtracted from the hourly temperatures for each hour it was over 85F, and the results totaled for the periods.

The first seven columns of figures are the degree-hours totaled for each of the summer months of 1942. The eighth and ninth columns show the total number of degree-hours experienced during the whole summer for both 1942 and 1941. The tenth and eleventh columns show the seasonal totals for each of the cities for the hottest and coolest summers of the past ten years.

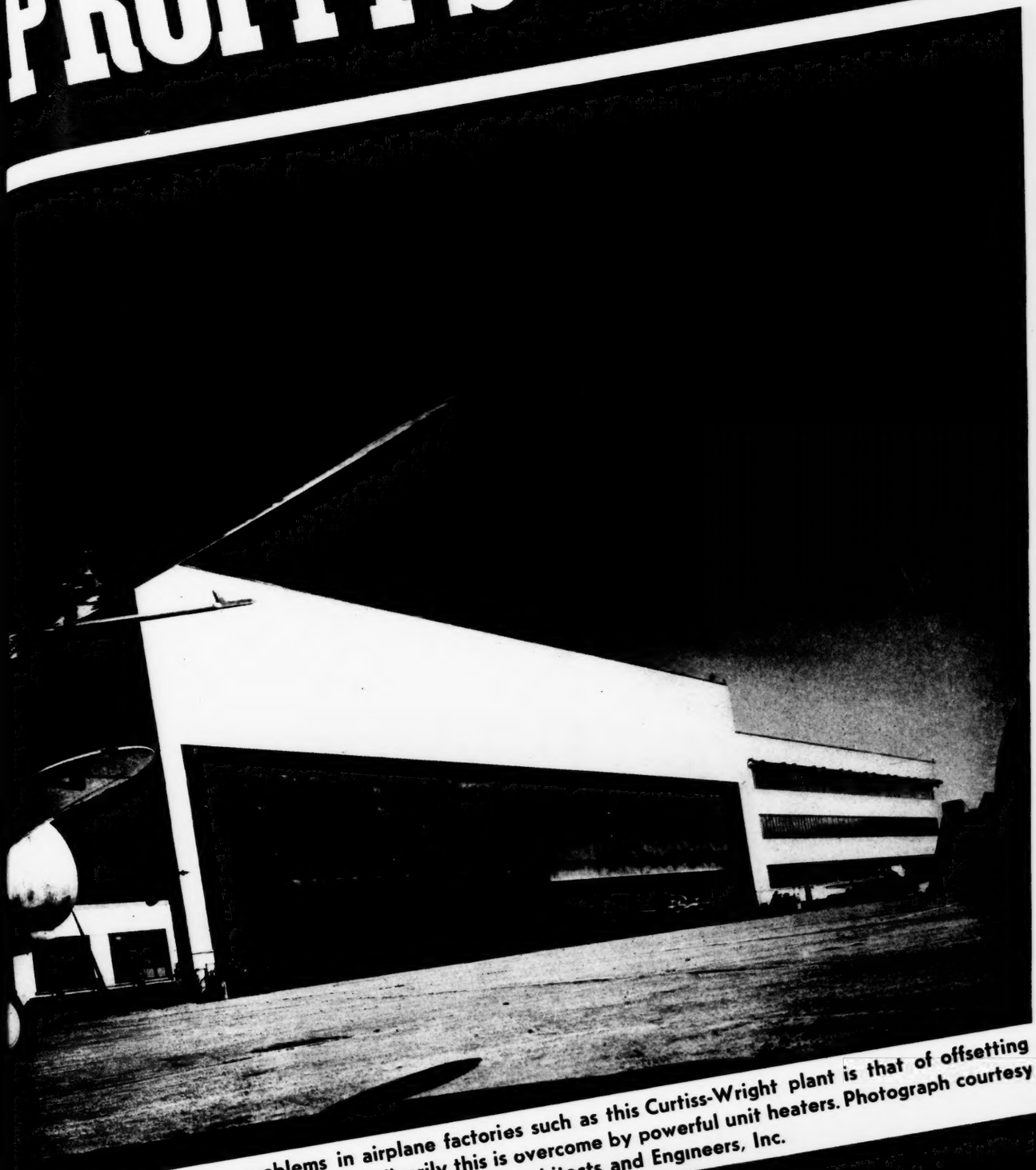
Of the 30 cities listed, only 2 showed a hotter summer this year than last, 27 indicated a milder summer this year than last, with insufficient data in 1 city.

## SUMMER DEGREE-HOURS (ABOVE 85F)*
### SUMMER OF 1942†

| City | April | May | June | July | August | Sept. | Oct. | Total, Apr. 1 to Oct. 31 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1942 | 1941 | Max. Yr. | Min. Yr. |
| Baltimore | 11 | 101 | 147 | 678 | 238 | 161 | 1 | 1337 | 2694 | 2694 | 1080 |
| Birmingham | 44 | 75 | 478 | 872 | 437 | 239 | 0 | 2145 | 2484 | 3906 | 1841 |
| Bismarck | 5 | 0 | 0 | 65 | 146 | 103 | 0 | 319 | 2040 | 4633 | 319 |
| Boston | 2 | 10 | 61 | 124 | 62 | 41 | 0 | 300 | 730 | 734 | 204 |
| Buffalo | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 12 | 34 | 113 | 11 |
| Chicago | 33 | 119 | 69 | 466 | 114 | 33 | 0 | 834 | 1080 | 1797 | 337 |
| Cincinnati | 11 | 50 | 156 | 365 | 93 | 29 | 0 | 704 | 1967 | 3937 | 704 |
| Cleveland | 10 | 14 | 97 | 313 | 10 | 41 | 0 | 485 | 1268 | 1268 | 142 |
| Columbus | 19 | 72 | 242 | 466 | 110 | 57 | 0 | 966 | 1824 | 2797 | 854 |
| Des Moines | 0 | 58 | 202 | 413 | 261 | 80 | 0 | 1014 | 2332 | 6560 | 1014 |
| Detroit | 4 | 40 | 38 | 336 | 23 | 11 | 0 | 452 | 1199 | 1879 | 340 |
| Fort Wayne | 8 | 95 | 77 | 264 | 0 | 14 | 0 | 458 | 1556 | 2741 | 353 |
| Houston | 0 | 140 | 706 | 806 | 666 | 351 | 34 | 2712 | 3791 | 4570 | 2712 |
| Indianapolis | 18 | 85 | 278 | 504 | 140 | 54 | 0 | 1079 | 2578 | 4432 | 672 |
| Memphis | 0 | 128 | 772 | 1557 | 553 | 354 | 3 | 3367 | 4323 | 4722 | 1942 |
| Milwaukee | 0 | 3 | 19 | 240 | 43 | 8 | 0 | 313 | 707 | 1090 | 233 |
| Minneapolis | 0 | 0 | 15 | 244 | 101 | 10 | 0 | 370 | 1282 | 3017 | 370 |
| New Orleans | 0 | 86 | 503 | 874 | 702 | 442 | 13 | 2620 | 3406 | 3476 | 2087 |
| New York | 1 | 20 | 3 | 143 | 25 | 33 | 0 | 225 | 488 | 560 | 75 |
| Oklahoma City | 0 | 123 | 504 | 1461 | 976 | 0 | 0 | 3064 | 4091 | No Data | |
| Philadelphia | 5 | 54 | 93 | 324 | 125 | 86 | 0 | 687 | 1340 | 1340 | 577 |
| Pittsburgh | 8 | 43 | 46 | 187 | 27 | 17 | 0 | 328 | 593 | 1262 | 293 |
| Portland, Ore. | 0 | 0 | 157 | 431 | 271 | 29 | 0 | 888 | 917 | 917 | 183 |
| Richmond, Va. | 77 | 111 | 335 | 876 | 328 | 229 | 0 | 1956 | 2877 | 2877 | 943 |
| St. Louis | 3 | 79 | 371 | 939 | 391 | 270 | 0 | 2053 | 3599 | 8361 | 2053 |
| San Diego | 0 | 2 | 0 | 0 | 0 | 0 | 12 | 14 | 13‡ | 456 | 0 |
| San Francisco | 0 | 7 | 2 | 0 | 0 | 12 | 0 | 21 | 6 | 201 | 0 |
| Savannah | 91 | 34 | 546 | 1710 | 796 | 585 | 5 | 3767 | 3649 | 3767 | 2320 |
| Toledo | 15 | 66 | 95 | 309 | 3 | 14 | 0 | 502 | 1158 | 2064 | 445 |
| Washington | 55 | 144 | 181 | 635 | 208 | 143 | 0 | 1366 | 2127 | 2127 | 1194 |

*Computed from data made available through the cooperation of the U. S. Weather Bureau.
†For some few cities the total includes a few degree-hours for March.
‡Includes six degree-hours for November, 1941.

# PROFITS IN AIR



One of the major heating problems in airplane factories such as this Curtiss-Wright plant is that of offsetting the tremendous heat loss at the doors. Ordinarily this is overcome by powerful unit heaters. Photograph courtesy of Albert Kahn Associated Architects and Engineers, Inc.

## HOW INDUSTRIAL PLANTS PROMOTE PROCESSES BY CONTROL OF AIR CONDITIONS

METALLURGICAL

FOODSTUFFS

ORDNANCE

CHEMICALS

AIRPLANES

FOUNDRIES

TOBACCO

TEXTILE

BAKERIES

ELECTRICAL

FILMS

INSTRUMENTS

GLASS

MACHINE SHOPS

PHARMACEUTICA

PLASTICS

PAPER

RUBBER

PRINTING

PROFITS IN AIR

# Glenn L. Martin Company's

## new building for manufacture of Navy bombers heated by oil-fired direct heaters; cafeteria and some offices are air conditioned.

By R. V. MEHAFFEY

Mechanical Engineer, Albert Kahn Associated Architects and Engineers, Inc.

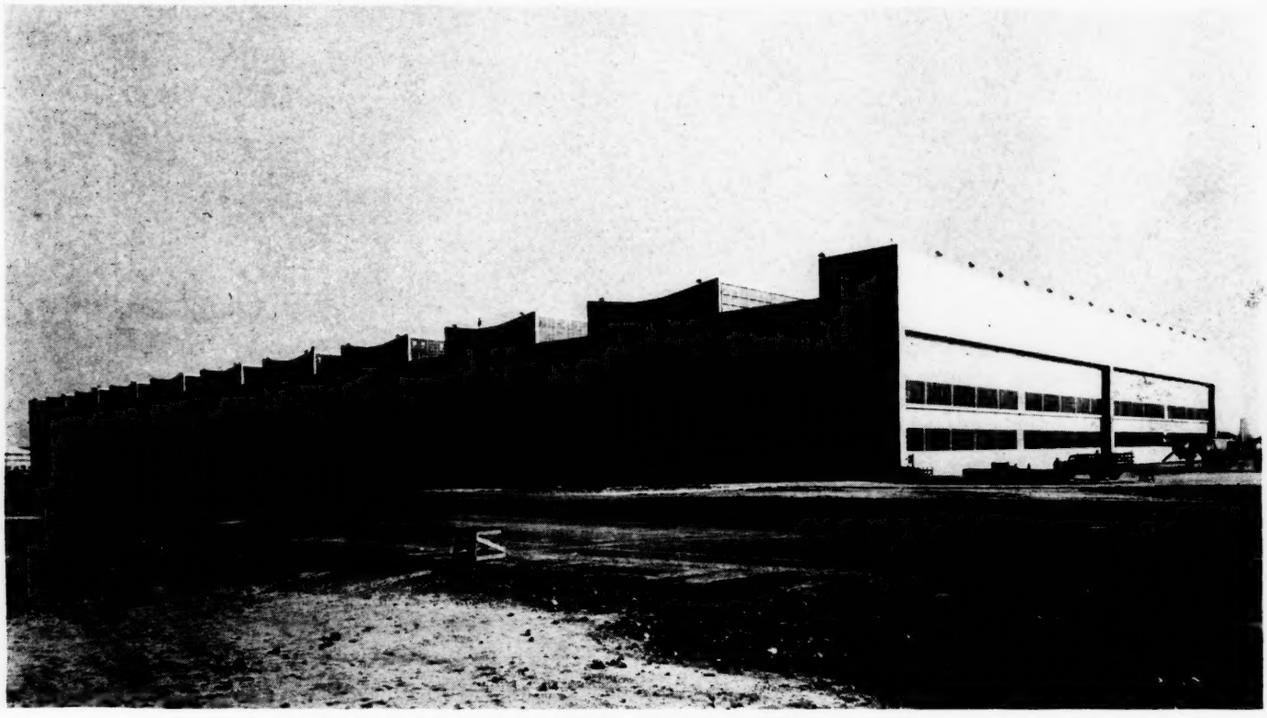
NAVY PBM bombers designed for ocean patrol are flying away regularly from the "Navy" building addition to Glenn L. Martin Company plant near Baltimore. The Navy building is an addition of modern design which incorporates important new structural features.

### General Arrangement

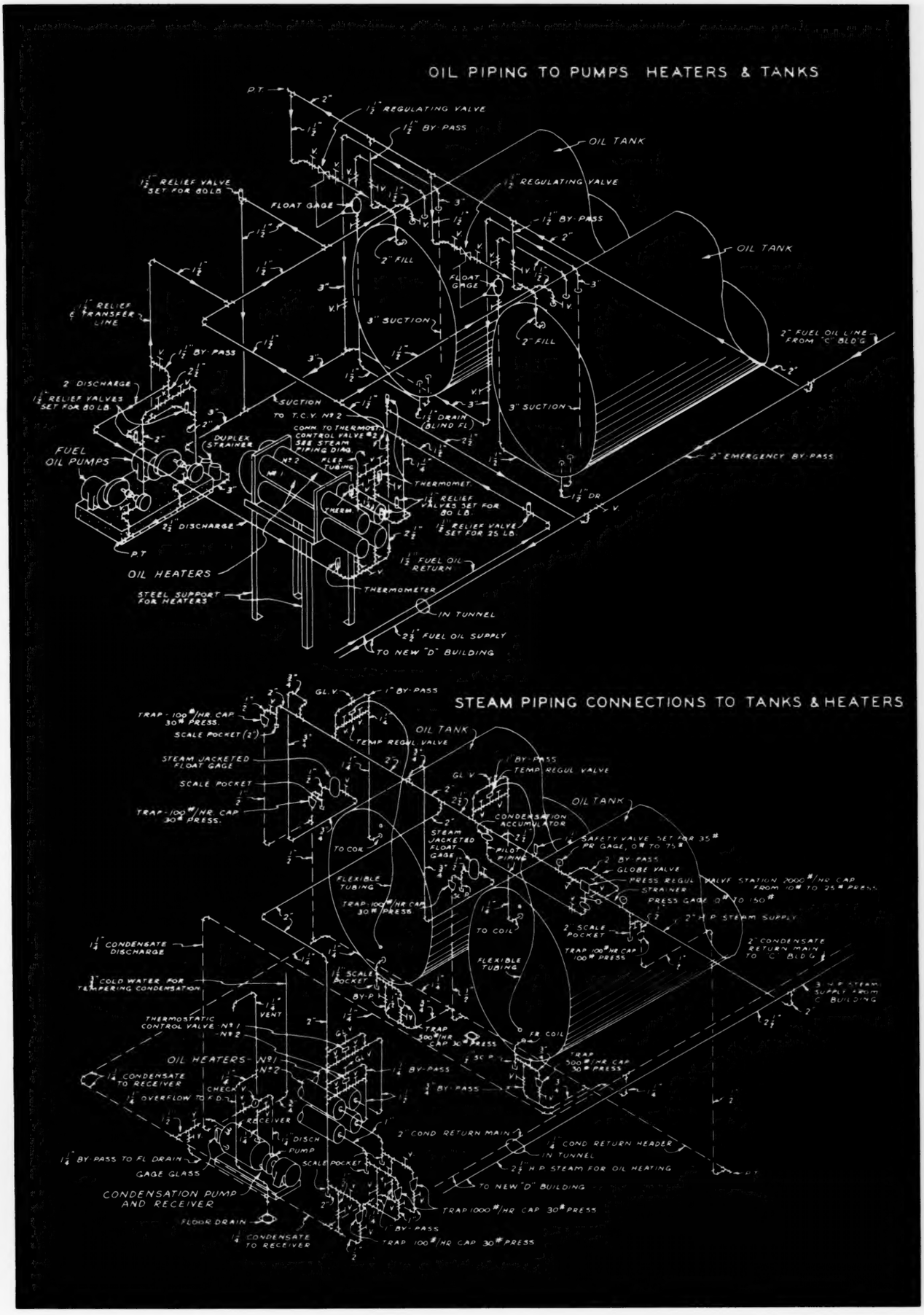
The design of the plant was selected in accordance with the requirements of the Navy and Glenn L. Martin officials. On the main assembly floor the restrictions of this gross area are reduced to an absolute minimum, involving only 15 stairways leading to the basement, five elevators and 15 groups of wash fountains, and two 12 x 15-ft openings for hoists. On a mezzanine above the first floor are located the first-aid rooms.

In the corresponding basement area, which is of the same size, there are seven rooms occupied by direct-fired furnaces, transformer and air-conditioning rooms, and two larger areas walled in for cleaning and finishing parts in connection with the manufacturing processes. Two first-aid rooms, toilets and wash rooms are located on a mezzanine elevation on the stairways between basement and first floor. A cafeteria, with an area approximately 100 x 150 ft is also located in the basement area.

The working area over the entire basement is



Glenn L. Martin "Navy" Building




**Piping details at the Glenn L. Martin plant**

lighted with fluorescent units suspended at an elevation to provide a 30-ft candle intensity. The clear height required for working space on the main floor level necessitates the use of incandescent lamp units which will consist of 750-watt lights suspended near the level of the lower chord of the trusses. The lighting on the main floor is designed to provide 35-foot candle intensity.

The peculiarities of aircraft plants such as the Martin Navy building warrant a special study of the problems confronting the heating engineer. Wide and high spans being necessary for the proper movement of plane parts for the huge machines meant eliminating all piping and equipment throughout the main floor of the plant. Still, with such a large building, with high steel sash and monitors 66 ft above the floor a certain difficulty existed for the designers. How could such an area be heated to maintain an even temperature with such an extreme loss through the sash and monitors? Some form of blanket heating would be the answer providing it could be moved at a reasonable temperature to offset the cold down-draft of infiltration. Thus it was decided to deliver air in large volume at a temperature somewhat above the desired room temperature at the floor line and at numerous intervals along the outside walls. If introduced at a suitable velocity it would so blanket the cold curtain of infiltration as well as cover the roof loss, circulating across the top of the building and dropping toward the center of the building where it would be picked up for recirculating purposes or exhausted to the atmosphere as desired.

Consequently, heated air is supplied from nine separate distributing stations, each equipped with a brick-set tubular, oil-fired air heater handling 85,000 cfm each, with a total normal heat delivery capacity of 7,250,000 Btu per hr, and with an overload capacity of 25% for short warming up periods. The heaters, inclosed in a heavy fire brick setting, consist of banks of steel tubes bent to a V-shape with the ends in cast iron headers. Tubes are separated from the combustion chamber by a thick bridge wall and protected by a layer of fire-clay baffle tile. The purpose of the V-shape construction of the tubes is for expansion and contraction without strain and also to increase the turbulence of the air passing through. The hot gases originating in the combustion chamber pass over the bridge wall, travel the full length of the heater and return through the tube chamber, finally exhausting through an induced draft fan. The air to be heated first passes over the outside of the heater where it is preheated and then enters the bent tubes, through which it is forced and delivered through a duct distributing system by fans operated at 2¼ in. static pressure driven by 60 hp motors. Fuel is piped from 15,000-gallon underground storage tanks where it is kept from freezing by a steam coil inserted into the tanks. From the tanks it is pumped through steam coil heaters where it is heated to a near flash temperature for easy atomizing and thence run through the building, wrapped with a steam line to maintain the temperature, to each individual burner. Each burner, gas-piloted, is supplied through a thermostatically-controlled electric heater complete with strainer, pressure gauge, thermometer and control, where it is again raised to a flash temperature and constant circulation is maintained at all times.

Condensation from this steam heating equipment is returned to a pump and receiver and pumped back to the boiler house.

A separate steam distributing system is installed connecting to the high pressure main at the boiler house and serving coils in the fan equipment for the cafeteria, water heater, kitchen equipment, all air conditioning units and process in the plating and cleaning room.

The cafeteria located in the basement area is supplied with conditioned air at the rate of 25,000 cfm. The system is designed to draw hot air from one of the heating units, outside air as required, or to recirculate if desired. The air is cleaned by an automatic oil filter, reheated by steam coils, or cooled by direct expansion coils according to seasonal requirements, and then distributed by means of a suitable duct system to ceiling type outlets.

One 75 hp refrigerating compressor serves the cafeteria, operating from duct controls located in the return air duct through a solenoid valve in the liquid line. When the liquid line solenoid valves are closed the compressors pump the refrigerant down and shut off through the action of low pressure controls which are also interconnected with the supply fan control, so that the compressors will not start unless the fan is in operation. Evaporative condensers located on the roof operate simultaneously with the compressors. A summer-winter transfer switch controls the supply dampers.

For cleaning the air of excessive smoke or fumes a separate exhaust fan is provided to discharge air to the atmosphere, or if desired recirculate to the system.

The two dishwashing rooms are ventilated by means of exhaust hoods over the washer through a duct system to a separate fan discharging to the atmosphere.

The kitchen is thoroughly cleaned of hot and greasy air through a range hood and grilles over the coffee urns and steam tables, thereby eliminating the excessive heat at its source, and connecting to an exhaust fan with fire by-pass from whence it is discharged out of doors.

Various offices and first aid rooms are conditioned with individual self-contained units for summer and winter use.

**THIS PROJECT**

**Architects and Engineers:**

**Office of Albert Kahn**

**Associated Architects**

**and Engineers, Inc.**

# PROFITS IN AIR

# *Milwaukee Journal*

## modernizes its fleet garage with boiler-burner units and unit heaters, decreases fuel consumption although service hot water load was added.

PROPER heating is considered as a necessity in efficient operation of a garage housing and servicing modern newspaper delivery trucks. At least this is true in the case of the private garage of the *Milwaukee Journal*, in which 250 to 300 cars and trucks are usually kept and maintained properly at a time. This newspaper had found it necessary to house trucks and cars in several garages in the neighborhood of the publishing house, so that the vehicles are ready at a moment's notice for trips which take them fifty to seventy-five miles from home. Desiring to keep all of the company's cars and trucks under one roof and one management for maintenance, a single building, 150 x 150 ft in size, was acquired, not far from the newspaper plant. The building was a fairly modern one, but the heating equipment left much to be desired. It consisted of a boiler and piping as shown in one of the illustrations. In place of this coal-fired steam equipment the new owners decided to install oil-fired multiple equipment, as shown in the second picture. Each of the four new boilers has a capacity of 450,000 Btu per hr.

After being remodeled, the garage was arranged into six zones — two for storage, one each for washing, greasing, repair room, office and shower room. Each of the spaces or rooms is heated by Trane unit heaters under control of thermostats located throughout the zones. The temperatures in the zones vary according to the needs of that division, as follows: Storage, 55F; wash rack, 70F; grease rack, 65F; shower, 75F; office, 72F.

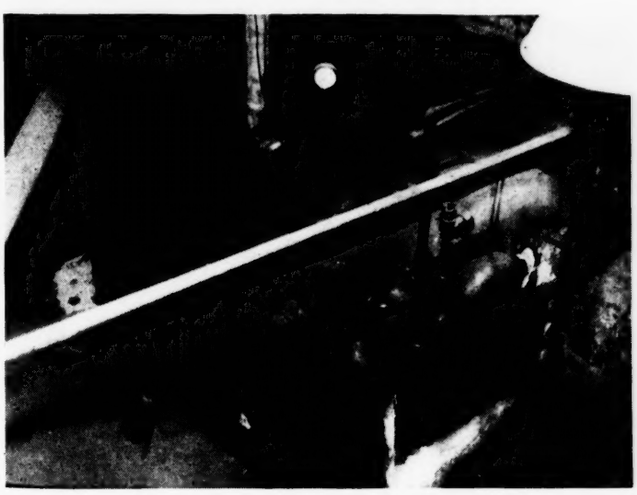
There is also a 250-gallon tank for hot water storage, with a water circulating pump which is controlled by an immersion aquastat installed in the tank, which circulates the water from the tank through indirect copper coils in each boiler. This provides controlled hot water automatically.

For one heating season (1939-40), before the new oil-fired equipment was installed, steam was supplied by the old boiler with a conversion oil burner unit, while the water for car washing, etc., was heated by means of a separate hand-fired coal-burning boiler. In September, 1940, the boiler-burner units were installed to furnish heat and service hot water.

A comparison of the fuel consumption before and after the change follows:

Fuel used by conversion unit and old boiler, season 1939-40, 31,800 gallons, which does *not* include water heating for the separate tank. Degree-days, 7087.

Fuel consumption, season 1940-41, with the boiler-burner units, 26,700 gallons, which *does* include heating water for car washing, etc., from separate tank. Degree-days, 6715.



**Boiler room of garage before the Milwaukee Journal acquired it, and prior to modernizing.**

**Boiler room after the oil-fired boilers were installed. Garage is divided into six zones.**

PROFITS IN AIR

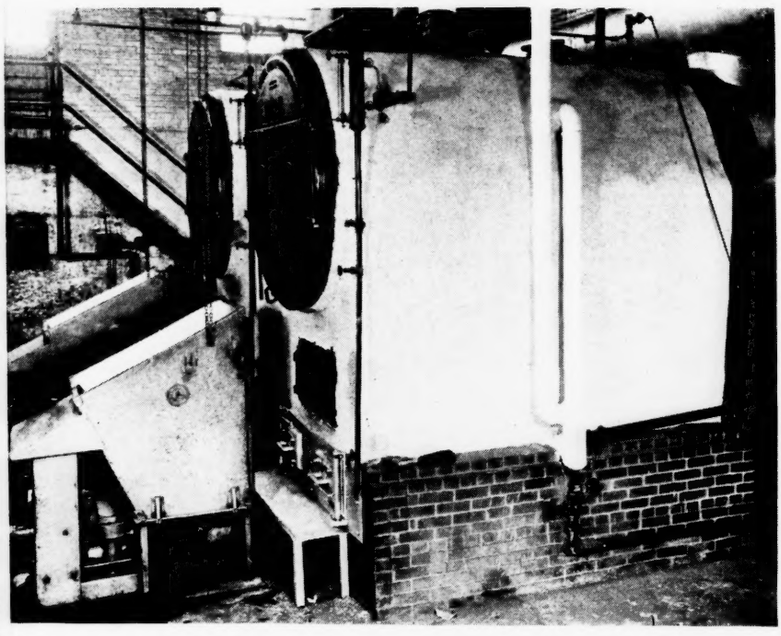
# Bearings Company of America

## reviews fuel records since installation of stokers, reports 28.7% savings in cost of fuel, better heating and less smoke as compared to hand-firing.

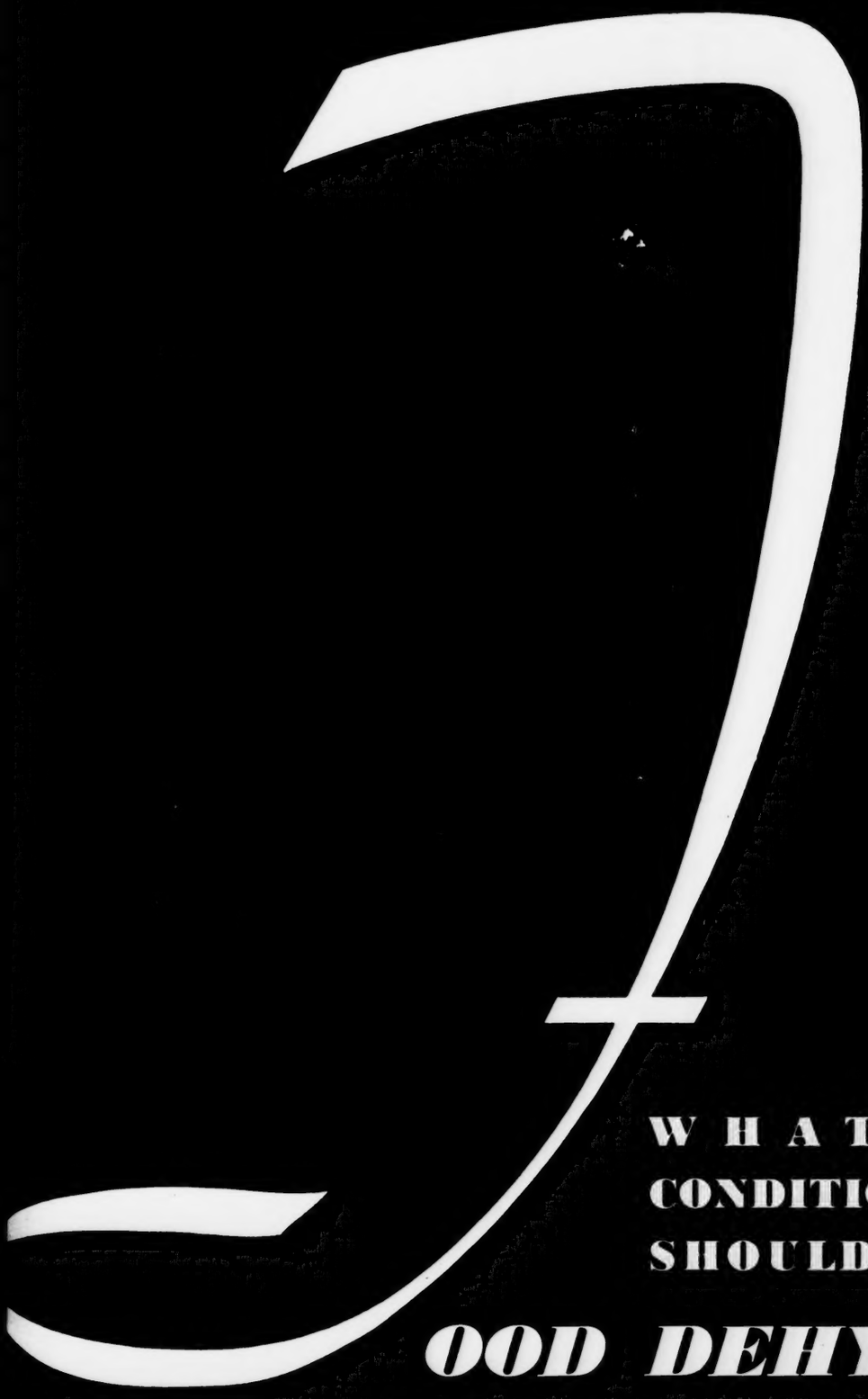
By FRANCIS A. WESTBROOK

THE Bearings Company of America, Lancaster, Pa., has saved an average of 28.7%, in the cost of fuel for heating its plant by substituting stoker-firing of its boilers for hand-firing. In addition to this, it is now possible to bring the temperature within the buildings up to the desired point more quickly on cold winter mornings and then to maintain it with much less variation during the working hours. Another advantage not taken into consideration in the 28.7% saving is the fact that the fireman has time for other duties now that the stoker-fired boilers do not keep him busy continuously. And, finally, the former very objectionable smoke nuisance has been practically eliminated by means of the stokers. In other words several important advantages have been realized on which it is difficult to place a dollars and cents value but which, nevertheless, have a very real bearing on the efficiency of the plant.

The boiler plant is solely for heating. It consists of two 100 hp Pacific boilers, each of which was equipped five years ago with a 550 lb per hr Iron Fireman stoker. During the last heating season with manual firing, 578 tons of run of the mine bituminous coal were used. The average consumption of coal for the three years succeeding, with stoker-firing, was 480 tons per year. The cost of the coal used for hand-firing was $5.03 per ton and the average with stoker-firing was $4.32 per ton. Thus with stoker-firing a smaller tonnage of cheaper grade coal gave better heating than with hand firing, using the same boilers and low pressure industrial heating system in the plant. Repairs have been negligible and there have been no shut-downs.



**(Left) Application of Iron Fireman stokers to these two Pacific boilers resulted in an average of 28.7% fuel savings as figured over an average of about five years. (Right) Plant of the Bearings Company of America in Lancaster, Pa., where the stoker installation was made.**



# WHAT THE AIR CONDITIONING ENGINEER SHOULD KNOW ABOUT

# FOOD DEHYDRATION

## A PROGRESS REPORT

HEATING AND VENTILATING'S REFERENCE SECTION

8

# FOOD DEHYDRATION AND

**Following the recent invasion of Africa, the sky is said to be the limit on the quantities of dehydrated vegetables that the U. S. government will be able to use during 1943. In other words, the developments in the far-from-static art of food dehydration during the past 18 months may be dwarfed by those to come. Consequently, this Reference Section, intended to present in practical and readable form the background, present status, and fundamentals of the relationship of Food Dehydration and Air Conditioning, is to be considered primarily a Progress Report.**

Food will win the war and write the peace. This seemingly broad statement is, however, by one in a position to be extremely well informed — Claude Wickard, Secretary of Agriculture. His comment takes on added significance as the war progresses. The food supply can—and occasionally does—determine whether a military position is tenable; control of the food supply can result in actual physical control of a country; the morale of a nation is dependent to a great extent on the food supply; a country's military forces are today largely dependent on food shipped from their bases. All this will not end with the coming of peace. Food-poor countries will still be dependent on the food-providing countries and consequently under their influence, probably to the extent stated by Mr. Wickard—that food will dictate the peace terms. The present food policy of the U. S. is greatly influenced by this premise.

This is of interest to the heating and air conditioning industry because our war food program has brought about a revival of one of the oldest methods of food preservation —Dehydration. Since the basis of food dehydration is a drying operation, and since drying is definitely within the province of the heating and air conditioning engineer, this Reference Section has been prepared to review the history and need for dehydrated food, the psychrometric principles of the drying operation, and the methods now being used, with the objective of providing at least the basic and background information on the subject.

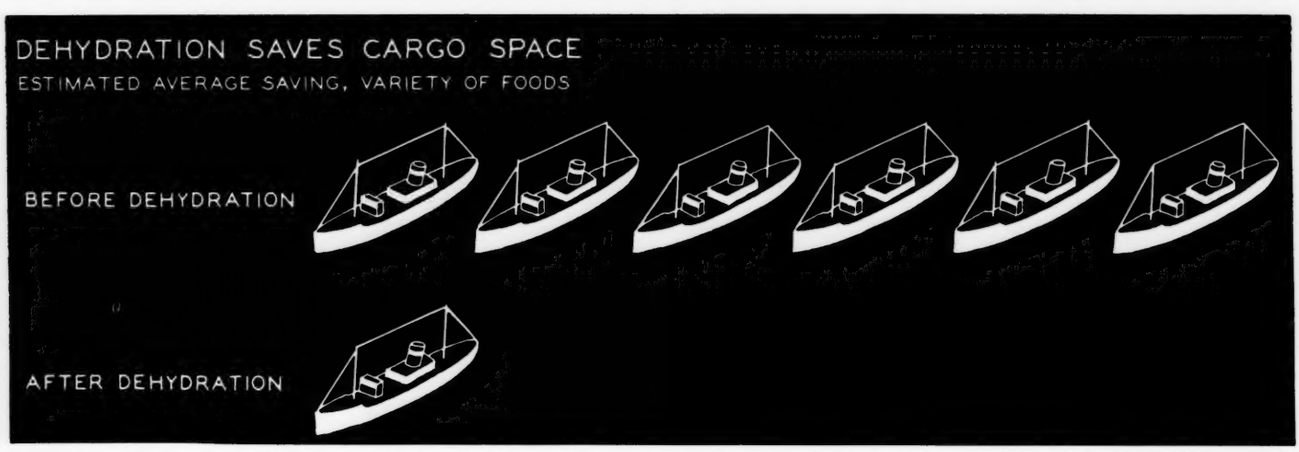
## DEHYDRATED FOOD

Dehydrated food is food from which the water has been removed under controlled conditions. When it is ready to be used the water is restored and the food is cooked in the normal manner. In most cases the form or shape of the food is altered but its flavor and food value are not appreciably changed. Vegetables are often processed a few hours after they are harvested while the vitamin content is still high and as a result dehydrated vegetables often contain more vitamins than the "fresh" vegetables usually bought in stores and markets. Dehydrated powdered eggs, for instance, are good not only for cake, doughnut and pancake dough, but for scrambling and making omelets. Dried lemons to which corn sugar has been added become a powder. Addition of water to the powder results in something very much like the original juice.

In appearance, most dehydrated vegetables resemble chips and shavings of colored wood, but after they have been soaked in water the tissues swell up and the vegetables are substantially restored to their original size and appearance. This preliminary soaking is usually known as "refreshening." After refreshening, dehydrated vegetables are salted to taste and cooked in the normal manner. Thinly sliced or shredded, heavily blanched dehydrated vegetables may be cooked in water without preliminary soaking. Since dehydration unavoidably removes some of the delicate flavors and odors, cooks are usually advised to be generous with seasonings, and the use of creamed sauces.

While the previous statements apply generally, it should be noted that it is not necessary to get the water back into all modern dried foods. A few dried foods, such as the compressed fruit bars supplied to parachute troops, are meant to be eaten in the dried form.

Dehydrated food offers a number of interesting advantages as a method of food preservation in the present wartime situation. It can be stored for long periods with no appreciable deterioration or loss of vitamins and food values, without the necessity of using cold storage refrigeration. It can be packed conveniently in non-metallic containers. It can save a tremendous amount of space and weight in shipment; one ship loaded with dehydrated food can do the work of six vessels with ordinary food cargoes. Even in wartime food takes up 40 to 50% of the tonnage



used in transporting goods among the United Nations. According to a statement from War Production Board, food dehydration will save 136,177 tons of packaging metal and 1,239,524 cars of shipping space in 1942-43.

Since fruits and vegetables consist of from 80 to 95% water, the savings in space and weight with dehydrated foods are astonishing. On an average 1/3 lb of fresh potatoes is required to serve each person at a meal, whereas 1/3 lb of dehydrated potatoes will serve 8 men. One pound of flaked carrots, restored in 21 lb of water, will serve 88 persons. One pound of flaked cabbage with 17 lb of water will make about 100 servings. A case of 30 dozen eggs weighs 58 lb and requires 2 cu ft of space; dried, these 30 dozen eggs weigh only 11 lb and occupy less than ½ cu ft of shipping space.

Of the billion dollars worth of foods shipped abroad (as of May, 1942) $170,000,000 were dehydrated dairy and poultry products, $4,300,000 were standard vitamin tablets or concentrates, and barely $700,000 were dehydrated vegetable products. Though only 1,500,000 pounds of dehydrated vegetables have been shipped under lend-lease, this phase of the program is due to expand spectacularly to meet the growing demands of lend-lease, the Army, Navy and even civilian consumption. The country's production of dehydrated vegetables for 1942 is expected to mount to 30,000,000 lb compared with 15,000,000 lb in 1941 and 6,000,000 lb in 1940. By 1943 dehydrated vegetable output will probably exceed 100,000,000 lb if present expansion plans are carried through; thereafter a rate of 200,000,000 lb per year is the goal. Large expansions in plant facilities are contemplated for milk and eggs, and for the relatively new dehydrated meats.

# DEHYDRATION TODAY

"Dehydration is as old as history itself. And sun drying, practised thousands of years ago, is still used extensively. Nature, of course, dries many of our staple foods for us—wheat, for example—and thus proves the worth of dehydration. Europeans have developed the science of dehydration to an extent far beyond anything seen in this country; without it there would have been no blitzkrieg. Only the Chinese approach the Europeans in variety and quantity of dehydrated food consumed.

"While we know of several instances in which dehydrated foods were used in the Civil War, in the Spanish-American War, and commercially as early as 1904, real production in this country began about 1912 and only assumed fair proportions in 1917 when about 12,000,000 pounds of dehydrated food were produced, over 8,900,000 of which were shipped overseas for the A.E.F.

"Of course, too, our New England forefathers early learned to dry corn, apples and other products; even today farmers in many sections of the country dehydrate substantial amounts of food for winter use. The dried foods do not taste like fresh and are not expected to; they simply add variety to a somewhat restricted winter diet.

"Our earliest knowledge of modern dehydration came from Europe. We imported the idea but very little in the way of trained personnel. As a result our efforts [in World War I] left much to be desired; in fact, the 15 or 20 producers then in existence made such poor products that the soldiers refused to eat dehydrated foods and, upon their return, condemned them so flatly that the industry was all but knocked out."†

In the light of today's knowledge of food technology many of the reasons for past failures can be explained. However, it has taken the past 10 years experience of the quick-freezing industry to develop some of the needed information. This is particularly true of vegetables, and had it not been for the freezing experience it is doubtful if the basic knowledge would exist today on which successful vegetable dehydration is progressing. Control of the enzymes in food seems to be the most important factor, and this is largely a matter of proper treatment of the food before drying. In fact, *what makes dehydration different today is the knowledge of the proper preparation of the food before drying and its care after drying.* These techniques have been developed to a large extent by the canning and the quick freezing industry, and consequently these industries are bound to play a large part in the expansion of dehydrated food output. A recent bulletin of the Department of Agriculture stated that "The production of dehydrated vegetables of *satisfactory quality* is more difficult

†From "Packaging Dehydrated Foods," by L. K. Harper, presented before the Packaging Conference, American Management Association, New York, April, 1942. Bracketed words added by editor.

**Fig. 2. Cabbages, beets, carrots, and potatoes—before and after dehydration**

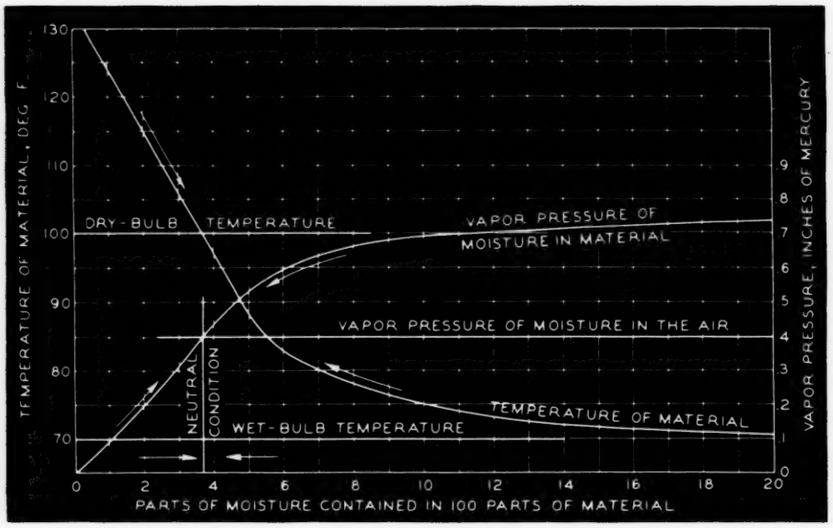

TEMPERATURE OF MATERIAL, DEG. F.
VAPOR PRESSURE, INCHES OF MERCURY
DRY-BULB TEMPERATURE
VAPOR PRESSURE OF MOISTURE IN MATERIAL
VAPOR PRESSURE OF MOISTURE IN THE AIR
NEUTRAL CONDITION
TEMPERATURE OF MATERIAL
WET-BULB TEMPERATURE
PARTS OF MOISTURE CONTAINED IN 100 PARTS OF MATERIAL

**Chart 1—Effect of moisture content upon the temperature and rate of drying of a typical hygroscopic material—in this case cotton. Reproduced from "Fan Engineering" (Buffalo Forge Company), by permission.**

than either quick freezing or canning. Any concern, therefore, undertaking this business without proven equipment and experienced direction will suffer financial loss and, what is more important, there will be a loss of food which under present conditions cannot be spared."

Consequently, the heating and air conditioning engineer should be cautioned that a thorough knowledge of food technology is required for the operation of a dehydration plant and that the actual drying of the food is only one phase of a number of stages through which the food must pass. Previous to drying, for instance, vegetables and fruits must go through the following processes: (a) washing, (b) grading for size, (c) peeling, (d) trimming, (e) checking, (f) subdividing, (g) pitting and seeding, (h) traying and (i) blanching.

Blanching is a particularly important process because its purpose is the inactivation, by heat, of enzymes responsible for undesirable changes in color, odor and texture and loss of vitamins during drying and subsequent storage, and also partial precooling in order that the dehydrated vegetables will refresh in water rapidly and cook quickly. Blanching is usually accomplished by subjecting the material to live steam at 190F for a required period, varying with different foods.

# METHODS OF DRYING

Drying as applied in the food industries refers to the removal of water from food products by evaporation. Other methods of drying, such as absorption, freezing and mechanical separation are not used extensively in food processing except, of course, that some free water is usually removed by mechanical dewatering equipment previous to the actual drying operation. In all the currently used methods of dehydrating foods (as listed and described later), with two exceptions, conditioned and controlled air is the principal drying medium, and accordingly a review of the theory of air drying is appropriate.

The drying or removal of moisture from foodstuffs is largely dependent on the difference in vapor pressure between the moisture in the pores of the food and the surrounding air, and the rate of diffusion of internal moisture to the surface of the food. As long as the vapor pressure of the moisture within the material is greater than the vapor pressure of the surrounding air, moisture will travel outward to the surface of the material and be evaporated. The vapor pressure of the internal moisture of material being dried is increased by heating. However, the vapor pressure of the moisture contained within a solid material should not be confused with the vapor pressure of a free liquid at the same temperature.

Solid materials such as food contain water in two forms. Water existing on the surface or held in the voids of the material is known as "free" or "unbound" moisture and its vapor pressure will be equal to that of water at the same temperature. "Bound," "hygroscopic" or "chemically combined" moisture, on the other hand, is intimately associated with the physical nature of the material, and its vapor pressure during drying is less than that of free water at the same temperature. The maximum amount of bound water that a material can contain is a characteristic of the material and is known as the fiber saturation point or critical moisture content. Below this point the amount of bound moisture is dependent on the temperature

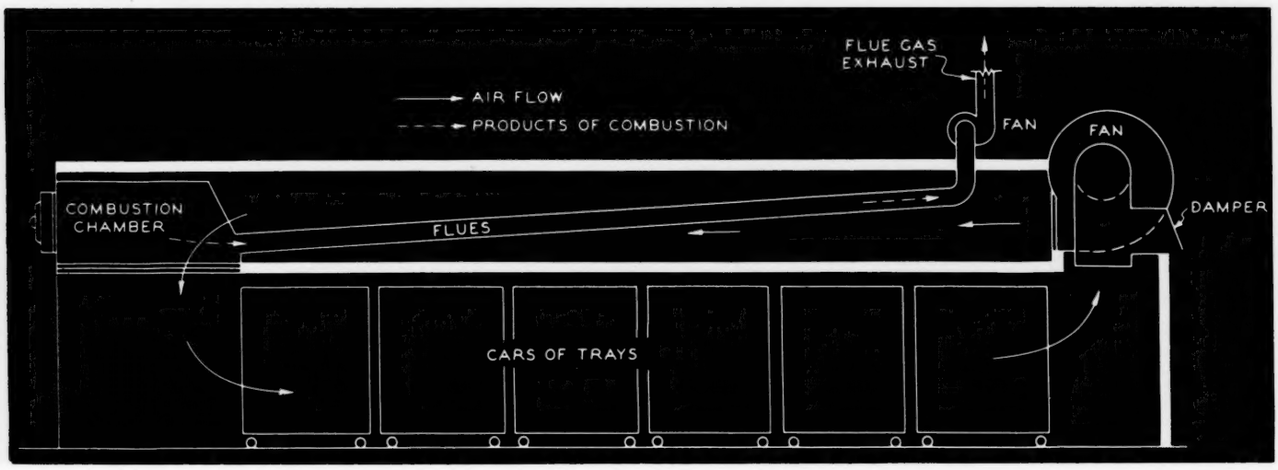



**Fig. 3. Indirect-type tunnel dryer showing heater air counterflow to movement of cars**

and relative humidity of the surrounding air with which it is in equilibrium. The relationship between the percentage of bound water and the condition of the surrounding atmosphere is a characteristic that varies for each material.

Chart 1 illustrates a typical drying cycle. Assuming that by proper control the dry bulb and wet bulb temperatures of the air are held at a constant point, in the initial stages of drying the temperature of the material is substantially equal to the wet bulb temperature of the air. This will continue as long as there is any free moisture in the material. As the drying progresses the temperature of the material deviates from the wet bulb and approaches the dry bulb temperature of the air while the vapor pressure of the moisture in the material decreases. Eventually an equilibrium or final condition is reached where the vapor pressures are equal and the material heats up to the dry bulb temperature of the air. As long as the material remains near the wet bulb temperature of the air the rate of drying is the same as in the evaporation from a free water surface, and is substantially constant (at constant velocity). When the critical moisture content is reached, the drying rate decreases and is no longer constant, since it is dependent on the structure of the material and effort required to bring the moisture to the surface. Drying during this period is known as the "falling rate period." As drying advances the process becomes slower until the condition of equilibrium exists and evaporation ceases. The ultimate time of drying will thus be governed by the rate of both evaporation and diffusion and *can only be determined by actual tests on the material.*

TABLE 1. SUMMARY OF DRYING PROCEDURES FOR VARIOUS VEGETABLES
(From "What's Known Today About Dehydrating Vegetables" by W. V. Cruess and E. M. Mrak, *Food Industries* (McGraw-Hill Publishing Co.), January, 1942)

| Vegetable | Cut for Drying | Blanch | Maximum Drying Temperature F |
|---|---|---|---|
| Asparagus | Cut to short tips. Use tender ones | Boiling water 3 min. | 145 |
| Broccoli | Stalks trimmed | Steam 10 to 12 min. | 150 |
| Beets | Sliced or diced | Cooked in steam before peeling | 125 |
| Brussels sprouts | Cut in half | Steam 5 to 10 min. | 150 |
| Cabbage | Thin slices | Steam 2 min. | 150 |
| Carrots | Peeled, sliced, diced or shredded | Steam 5 to 10 min. | 160 |
| Celery | Short lengths ¼ in. or shredded | Steam 1 to 2 min. | 145 |
| Chard | Trimmed washed leaves | Steam 3 to 5 min. | 150 |
| Corn | Cut from cob after blanching | Steam or boiling water 5 to 20 min. on the cob | 160 |
| Garlic | Sliced | Steam 1 to 2 min. or no blanch if for powder | 135 |
| Horse beans | Shelled | Steam 5 to 10 min. | 145 |
| Jerusalem artichokes | Sliced | Steam 4 to 5 min. | 160 |
| Kale | Trimmed leaves | Steam 3 to 5 min. | 150 |
| Green lima beans | Shelled | Steam 5 to 10 min. | 150 |
| Onions | Peeled, sliced thin | No blanch or only 1 to 2 min. in steam | 140 |
| Okra | Sliced | Steam 4 to 5 min. | 150 |
| Mushrooms | Whole, stalks sliced (Peeled preferably) | Blanch in live steam for 3 to 5 min. | 150 |
| Parsnips | Peeled, sliced, diced or shredded | Steam 5 to 10 min. | 160 |
| Peas | Shelled | Steam 5 to 10 min. | 150 |
| Peppers and pimientos | Whole | No blanch | 150 |
| Potatoes, white | Peeled, sliced, diced or shred | Steam 5 to 10 min. | 150 |
| Potatoes, sweet | Peeled, sliced, diced or shred | Usually cooked before peeling Otherwise steam 5 to 5 min. | 150 |
| Pumpkin and yellow squash for powdering | Sliced | Steam 4 to 6 min. | 150 |
| Rhubarb | Lengths of ½ in. or less | Steam 2 min. | 150 |
| Spinach | Trimmed washed leaves | Steam 2 to 3 min. | 150 |
| Summer squash and zucchini | Sliced | Steam 4 to 6 min. | 150 |
| Tomatoes for stewing | Peeled, Sliced | Steam 1 to 2 min. | 150 |
| Tomatoes for powdering | Cored and sliced. Not peeled | No blanch or steam 2 min. only | 150 |
| Turnips and rutabagas | Peeled, sliced, diced or shredded | Steam 5 to 10 min. | 150 |

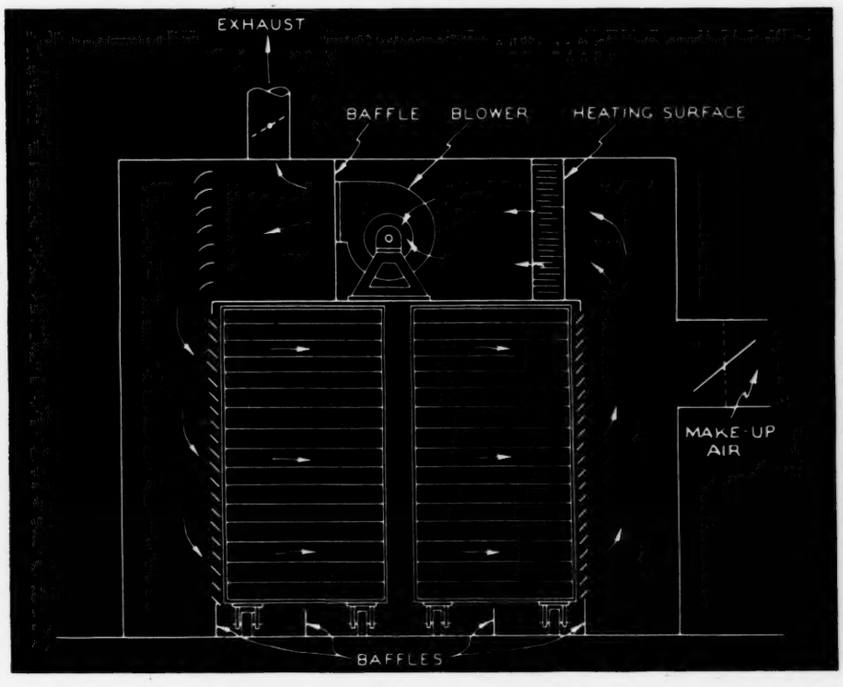



**Fig. 4. Compartment dryer, showing trucks, with air circulation by a centrifugal blower. Axial-flow fans are sometimes used in place of centrifugal fans**

It is important that the condition of the air be so controlled that the rate of evaporation at the surface will not be greater than the rate of moisture delivery to the surface from the exterior of the drying mass, otherwise (in the case of some foodstuffs) the surface will be dried so rapidly that it will harden and contract forming an outer covering which is almost impervious to the passage of further moisture from the interior. It is to prevent this "case hardening" that humidity control is a necessary element of vegetable dehydration, some materials requiring that the initial drying stages proceed under a condition of high humidity.

The temperature at which various products are dried is ordinarily as high as may be used without injury to the material. Tables 1 and 2 show the safe drying temperatures for various fruits and vegetables. Table 3 gives some drying information on some other representative products. It is to be noted that, excepting cereals, these are all rather low, the highest being 190F. Nuts and breakfast foods, on the other hand, can be dried to 200 to 300F. Some fruits and vegetables are more susceptible to heat injury than others but all are injured by even short exposures to high temperature. It is generally agreed that the lower the temperature at which food is

dried the better will be the flavor and vitamin retention. On the other hand, the more rapidly the products have been dried the better the quality, since injury can be caused by prolonged exposure at comparatively moderate temperatures.

"Vegetables must be dried to much lower moisture content than fruits if they are to keep satisfactorily owing to the fact that they have a much lower ratio of water-soluble solids to the unsoluble solids. The starch in the vegetables does not dissolve in the vegetable juice, whereas the sugar of fruits does dissolve. Consequently, on drying, the juice in the fruit becomes highly concentrated in sugar content which prevents growth of yeasts, molds and bacteria. The juice in vegetables is thin and low in sugar and other solubles. So it must be concentrated to very small volume in order that the resulting syrup will have sufficient preservative power to prevent spoilage by micro-organisms. Also if the moisture content of the dried product is above a certain minimum, non-bacterial deterioration will be rapid. This is especially true of unblanched vegetables."[1]

Tables 1 and 2 give the proper final moisture contents for various vegetables. It is to be noted that most vegetables should be dried below 6%, whereas the recommendations for fruits run around 15%. Below the moisture contents given in the tables vegetables are considered "bone dry," and if they are protected from insects and moisture uptake they usually will keep in good condition for more than a year.

[1] "What's Known Today About Dehydrating Vegetables," by W. V. Cruess and E. M. Mrak, *Food Industries* (McGraw-Hill Pub. Co.), Feb., 1942.

TABLE 2.—DETAILS OF DEHYDRATION OF FRUITS AND VEGETABLES

(Abstracted from "Preservation of Fruits and Vegetables by Commercial Dehydration," by Chace, Noel, and Pease; Circular 619, U. S. Dept. of Agriculture)

| Product | Yield of Fresh Prepared Product from Fresh Unprepared Product, % | Form for Drying | Approximate Tray Load per Square Foot, Lb. | Treatment | | Maximum Drying Temperatures, F | Average Drying Time, Hr. | Dried Product | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Type | Time, Min. | | | Preferred Moisture Content, % | Yield from | |
| | | | | | | | | | Fresh Prepared Product, % | Fresh Unprepared Product, % |
| Fruits: | | | | | | | | | | |
| Apples | 65-75 | Cubes or slices | 1.5 | Sulfur | 15-30 | 140-160 | 6-10 | 10-15 | 16-19 | 10-15 |
| Apricots | 90-94 | Halves | 2.0 | Sulfur | 15-25 | 135-155 | 10-20 | 15-20 | 17-20 | 15-19 |
| Bananas | 52-57 | Whole or slices | 1.0 | Sulfur | 15-30 | 140-160 | 10-20 | 15-20 | 28-31 | 13-18 |
| Cherries (unpitted) | 97-99 | Whole | 1.0 | None or steam | 0-2 | 135-160 | 8-12 | 15-20 | 25-30 | 24-30 |
| Cherries, sweet (pitted) | 77-83 | Whole | 1.0 | None or steam | 0-2 | 135-160 | 8-12 | 15-20 | 24-28 | 18-24 |
| Cranberries | 100 | Chopped pieces | .8 | None or steam | 0-2 | 135-150 | 4-8 | 5-10 | 10-14 | 10-14 |
| Figs | 100 | Whole | 3.0 | Boiling lye dip[3] | 1/2-1/2 | 135-160 | 10-20 | 15-20 | 24-27 | 24-27 |
| Grapes | 80-90 | Subdivided clusters | 3.5 | Boiling lye dip[3] | 1/2-1/2 | 150-180 | 20-30 | 15-20 | 26-30 | 21-27 |
| Loganberries | 100 | Whole | 1.2 | None | | 140-150 | 10-15 | 10-15 | 15-18 | 15-18 |
| Peaches | 85-90 | Halves | 2.5 | Sulfur | 15-30 | 145-155 | 15-24 | 15-20 | 17-21 | 14-19 |
| Pears | 75-80 | Halves | 2.5 | Sulfur | 15-30 | 140-150 | 15-24 | 10-15 | 17-20 | 12-17 |
| Prunes | 100 | Whole | 3.0 | Boiling lye dip[3] | 1/2-3/4 | 145-160 | 20-30 | 15-20 | 33-38 | 33-38 |
| Raspberries (black) | 100 | Whole | 1.0 | None | | 140-150 | 10-15 | 10-15 | 16-20 | 16-20 |
| Rhubarb | 55-60 | Slices | 1.0 | Steam | 2-4 | 140-150 | 10-15 | 5-10 | 6-9 | 2-7 |
| Vegetables: | | | | | | | | | | |
| Beans (green) | 87-92 | 3/4-inch lengths | .8 | Steam | 15-20 | 140-155 | 8-12 | 5-10 | 10-13 | 8-12 |
| Cabbage | 80-85 | Slices or shreds | 1.0 | Steam | 2-6 | 140-150 | 8-12 | 5-7 | 8-12 | 6-10 |
| Carrots | 77-82 | Cubes, slices, or shreds | 1.5 | Steam | 4-8 | 150-160 | 8-12 | 5-10 | 11-14 | 8-12 |
| Celery | 77-82 | Slices or shreds | 1.0 | Steam | 1-2 | 135-145 | [3] 3-6 / [2] 8-10 | 5-10 | 6-9 | 4-8 |
| Corn | 35-40 | Whole kernels | 1.7 | Steam | 15-20 | 150-165 | 5-10 | 5-10 | 25-28 | 8-12 |
| Onions | 88-93 | Slices or shreds | 1.2 | Steam | 1/2-1 1/2 | 140 | 5-10 | 5-7 | 12-15 | 10-14 |
| Parsnips | 77-82 | Cubes, slices, or shreds | 1.2 | Steam | 2-5 | 150-160 | 8-12 | 5-10 | 18-22 | 14-18 |
| Peas (sugar) | 55-60 | Whole | 1.0 | Boiling water | 1-2 | 140-150 | 8-12 | 5-10 | 18-22 | 9-14 |
| Potatoes | 78-82 | Cubes, slices, or shreds | 1.2 | Steam | 5-7 | 145-155 | 8-12 | 5-10 | 22-25 | 17-21 |
| Pumpkin | 70-75 | Cubes, slices, or shreds | 1.5 | Steam | 3-6 | 140-155 | 12-16 | 5-10 | 7-9 | 4-8 |
| Squash (Boston Marrow) | 70-75 | Cubes, slices, or shreds | 1.5 | Steam | 3-6 | 140-155 | 14-18 | 5-10 | 11-14 | 7-11 |
| Spinach | 45-55 | Whole leaves | .5 | Steam | 1 | 180 | 6-10 | 5-7 | 7-11 | 3-6 |
| Sweetpotatoes | 75-80 | Slices | 1.5 | Steam | 6-8 | 160 | 5-10 | 5-10 | 32-35 | 24-28 |
| Tomatoes | 70-85 | Slices | 1.2 | None or steam | 0-3 | 140-150 | 10-14 | 5-8 | 5-8 | 3-7 |
| Turnips | 75-80 | Cubes, slices, or shreds | 1.2 | Steam | 2-5 | 145-155 | 8-12 | 5-7 | 10-12 | 7-10 |

[2] Leaves. [3] Stalks. [3] Use 1- to 3-percent lye solution. After lye dipping, rinse fruit by momentary dip in fresh cold water.

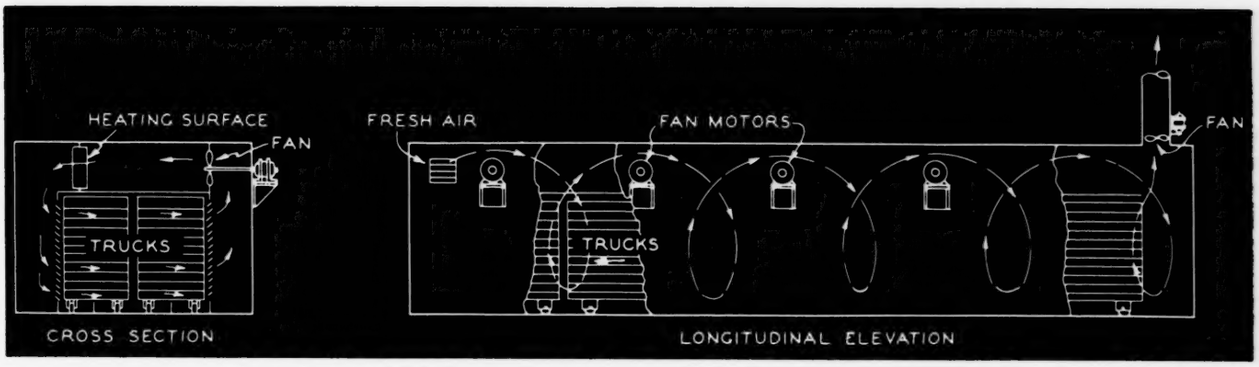



**Fig. 5. This type tunnel dryer consists of a multiplicity of compartment dryers placed in series. The fans spaced longitudinally keep the air in circulation.**

# TYPES OF DRYERS

Dryers are generally classified as follows:

I—Batch Dryers
- (a) sun dryers
- (b) loft dryers
- (c) compartment dryers
- (d) vacuum dryers

II—Continuous Dryers
- (a) tunnel dryers
- (b) conveyor dryers
- (c) rotary dryers
- (d) spray dryers
- (e) drum and cylinder dryers.

Sun dryers and loft dryers are, of course, crude, inefficient, and uncertain methods that are sometimes used on low cost products but which have no place in the present accelerated production of high quality dehydrated food.

## Compartment Dryers

Compartment dryers are probably the most extensively used type in almost all fields of drying and the variations in design, shape and size are numerous. However, the basic principles of this type dryer are illustrated in Fig. 4. The outer shell is usually constructed of air tight hollow sheet metal panels filled with insulating material. The material to be dried is placed on trays or flat sheets arranged in tiers. The stacks of trays can either be mounted on trucks which are rolled in and out of the drier or the racks can be fixed in place with removable sliding shelves in which case the dryer is called a "shelf" dryer. Trays are preferably made of stainless steel with perforated bottoms but various forms of wood trays have been successfully used in dehydrating vegetables.

Either centrifugal blowers or axial flow fans can be used, depending on the design detail, and the resistance to the flow of air occasioned by the numerous possible variation in air distributing methods. Care must be exercised in getting uniform air distribution over the trays. Both types of fans have been used successfully. The source of heat can be steam, electricity, direct or indirect fired gas, oil, or coal, although the most common methods are those using steam, with extended surface coils, and indirect fired gas.

In a typical set up the dry bulb thermostat would control the heat input and a wet bulb thermostat or humidistat would control the dampers regulating the amount of make-up and discharged air. Humidity is decreased by introducing more outside air, and vice-versa. The rate at which make-up air is introduced, of course, largely determines the rate of moisture removal.

Advantages of the compartment dryers are flexibility and simplicity. They are necessarily limited in size but any single plant may have a large number of them permitting the production of a variety of products without intermingling of flavors, etc. They can be made mobile, so as to "follow the crops." Another advantage of the compartment dryer is that blanching by means of steam sprays can sometimes be accomplished within the dryer itself. The compartment can be loaded with food, the steam sprays turned on the required time, and then air circulation and drying operation can follow immediately. Blanching in the compartment dryer serves also to heat up the material. Thus when drying starts and the surface cools due to evaporation the interior will be of higher temperature and vapor pressure and thus the drying will be more rapid. All food cannot be blanched in this manner because in some cases a washing operation must follow the blanching.

## Vacuum Dryers

Vacuum drying, wherein the vapor is literally pulled from the material, has the advantage of permitting very low drying temperatures and eliminating the possibility of oxidation because of the presence of air. However, vacuum dryers are seldom used in large scale operations on the usual commercial grades of dehydrated fruits and vegetables. The apparatus is comparatively expensive and complicated and usually the advantages gained are not sufficient to compensate for the added cost of equipment and operation. Moreover, under the present wartime conditions, these dryers are practically ruled out because they require large quantities of steel and items of machinery, such as pumps and condensers, which are urgently needed elsewhere.

## Tunnel Dryers

The tunnel dryer is essentially a form of compartment dryer in which a large number of trucks of trays are placed in one continuous line and moved through a tunnel by mechanical means either continuously or at definite time intervals. Figs. 3 and 5 illustrate this type of dryer, which is used extensively on the

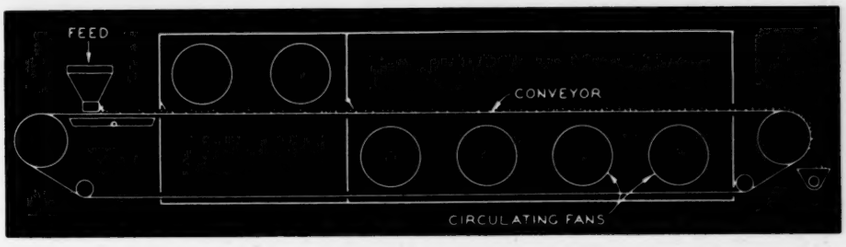



**Fig. 6. Dryer of the conveyor type. The arrangement of compartments is such as to give rapid drying.**

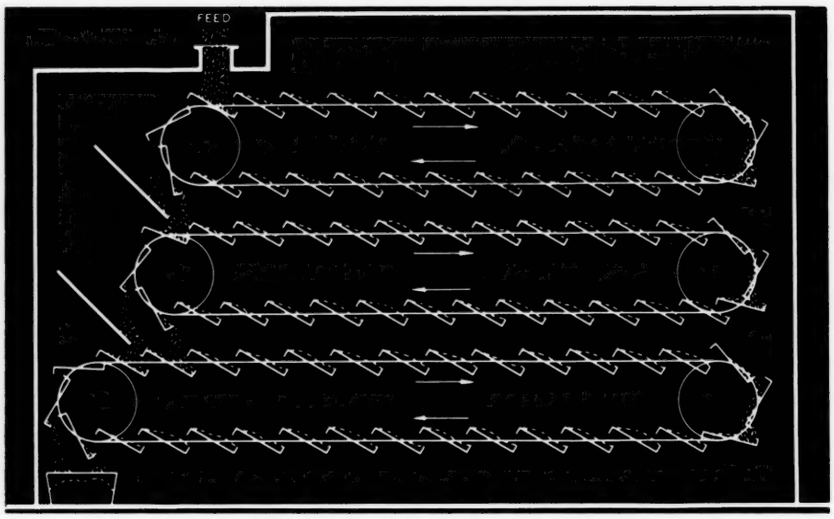



**Fig. 7. Reversing pan type conveyor dryer. Material drops at the end of each pass on to tray below, resulting in exposing all of the surfaces of the material to be dried to the drying air.**

West Coast for fruit drying. Although the dimensions and capacities of tunnel dryers vary widely, a typical tunnel is about 40 ft long, 6 ft wide, and 6 ft high, and is capable of holding a single line of 10 trucks.

It is possible to have three types of flow through the tunnel—counter flow circulation of the heated air, parallel flow, or a combination of both in which the air is introduced at the center of the tunnel and circulated toward each end. If only part of the moisture is to be removed it may prove advantageous to introduce the air at the green (wet) end and exhaust it at the other, since the material will be withdrawn at the lower temperature and consequently with less loss of heat. On the other hand, with counter flow operation more rapid drying can take place since the temperature and vapor pressure gradient is always at a maximum. Moreover, materials can be dried to a lower moisture content since the material at the end of its run through the tunnel meets the driest air. Similarly, counter current dryers minimize the possibility of case hardening, since the wettest material is in contact with the leaving air which has the highest percentage of humidity. Parallel flow would have an advantage in cases where the material might be damaged because of extreme sensitivity to high temperature in its dried state. Because of the large size of tunnel dryers and the large quantities of heat required, direct firing is often used, and the furnace is an integral part of the dryer.

Tunnel dryers can be easily constructed of non-metallic materials which makes their use attractive at this time. During August of 1942, the U. S. Department of Agriculture, Bureau of Agricultural Chemistry and Engineering, issued detailed drawings, specifications and descriptions of a few designs of tunnel dryers. These may be obtained by writing to R. S. Hollingshead, Assistant Chief of Agricultural Chemical Research Division, U. S. Dept. of Agriculture, Washington, D. C.

## Conveyor Dryers

Conveyor dryers are tunnel dryers in which the material is moved through the drying chamber on endless belts of various forms. Figs. 6 and 7 illustrate this type. Usually the belts are made of slats or wire mesh. Conveyor dryers are used successfully in completing the drying of partially dried raisins and in drying sweet corn. This method is not suited to fruits that stick to the belts or to fruits likely to be injured by dropping from one belt to another when multiple staggered belts are used. Neither are such dryers adapted to irregular or discontinuous loading and drying operations. Because of their limitations and their small loading capacity conveyor belt dryers are less practical than tunnel and compartment dryers for general use.*

## Rotary Dryers

In this type of dryer, which has wide applications, the material is fed into one end of a cylindrical chamber revolving about a horizontal axis. The cylinder is usually slightly inclined so that the material moves from one end of the cylinder to the other by gravity and is agitated at the same time by the revolving motion of cylinder. As in the case of tunnel dryers, both parallel flow and counter current flow are used, the latter being the more common.

A convenient classification of rotary dryers, on the basis of the application of heat, results in three categories: (a) direct; (b) indirect; and (c) direct-indirect.

In direct rotary dryers the material comes into direct contact with the drying medium which can be air preheated outside of the cylinder by a furnace or steam coils or the air can be mixed directly with products of combustion. Figs. 8, 9 and 10 illustrate the Roto-Louvre dryer which

*U. S. Dept. of Agriculture Circular 619.

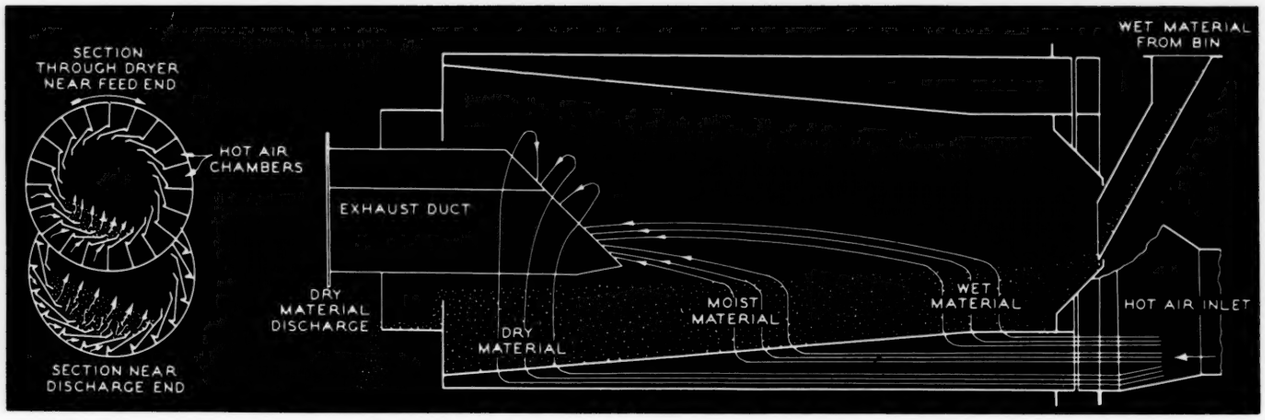



**Fig. 8. Cross-sections and longitudinal section through the Roto-Louvre dryer. Although not shown in the longitudinal section, the hot air chambers extend throughout the length of the dryer.**

is a form of direct rotary dryer originally developed in Sweden and England.

"The action of the material within this dryer is a gentle turning over on itself and this action accomplishes several things. It practically eliminates degradation of the particle or crystal size and also reduces the wear of the inner surface of the dryer to a minimum. It also provides for the alternate changing of contact with the material and the high and low temperatures of the heated air already mentioned. The way in which this is accomplished is that the material next to the louver plates is first exposed to the highest temperatures of the hot air and then, as it flows back over the top, it is contacted with the hot air greatly reduced in temperature, due to the evaporation that has taken place.

"The hot air is not admitted to all the passages around the circumference of the dryer but only to those immediately underneath the bed of material. The others are blanked off so that the air cannot enter or they may, as has been done in some cases, be used for exhausting the vapors. Generally, however, the exhaust gases are taken out at the discharge end of the dryer.

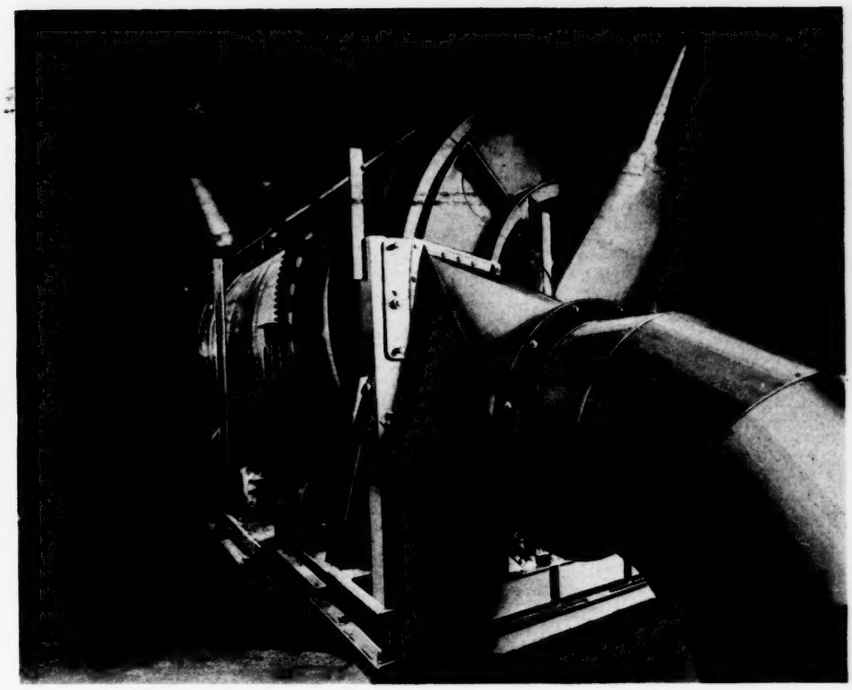


**Fig. 9. Exterior view of the Roto-Louvre dryer. Figs. 8, 9 and 10 reproduced by permission of Link-Belt Company.**

"This dryer operates at a very low rpm as the rotation functions simply as a conveying medium in passing the material through the dryer and not as a medium of aeration."‡

In the indirect rotary dryers the material does not come in contact with the heating medium. The heat is applied to the exterior of the cylinder or by flues or pipes passing through the cylinder parallel to its longitudinal axis. The rotary steam tube dryer, Fig. 12, is an illustration of a variation of this type dryer. Heat is furnished by banks of steam tubes placed in concentric circles inside the cylinder and rotating with it. Air circulation is limited to that necessary to carry off the evaporated moisture. The food will not stick to the tubes, partly because of the expansion and contraction of the tubes, and partly because wet material will not generally stick to a metal surface which is hot enough to cause instantaneous evaporation.

Direct-indirect rotary dryers are a combination of the two preceding classifications. The usual arrangement for this dryer is to have the products of combustion first heat the exterior wall of the cylinder and then pass through the cylinder itself in contact with the material. Fig. 14 schematically illustrates this type of dryer.

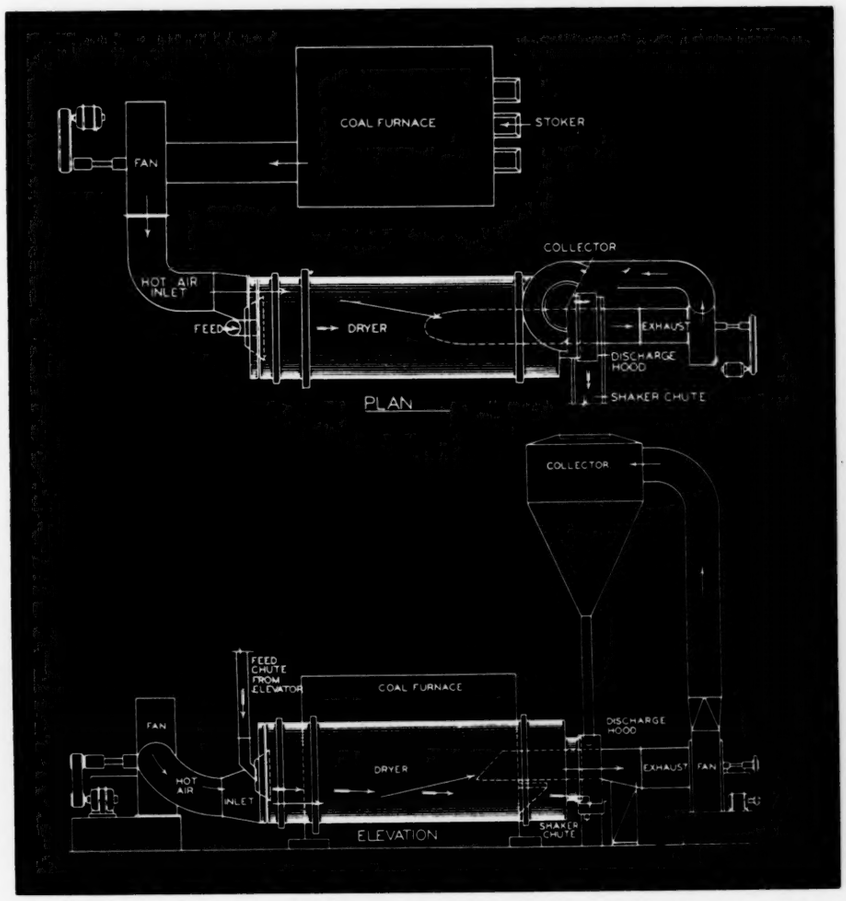
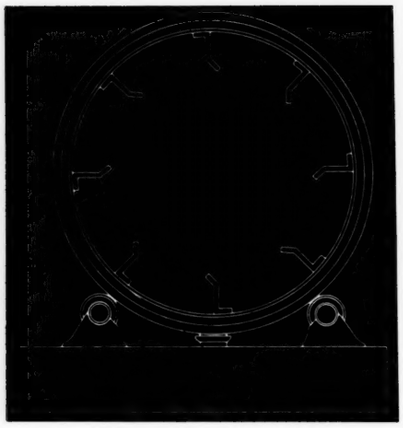



**Fig. 10. Plan and elevation of a typical coal-fired installation of a Roto-Louvre dryer. Gas, oil or steam can also be used as a source of heat for this dryer.**

## Spray Dryers

Spray dryers are conventionally limited to food products which can be placed either in solution or in a

‡From "Principles and Applications of Drying or Dehydration," by John Erisman, Link-Belt Co., presented before the Western Society of Engineers, October, 1942.



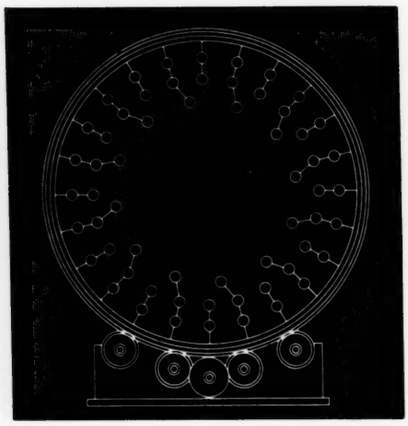


**Fig. 11. (Left) In this direct-heated rotary-type dryer the purpose of the blades is to agitate the material being dried. Fig. 12. (Right) A steam tube dryer in which a steam drum is fastened on the inside of the cylinder, rotating with the steam tubes so as to increase the heating surfaces. The fall of the material is checked due to the arrangement of the tubes.**

state of very fine subdivision. It is the most common method for drying milk and eggs, and can also be used for drying fruit juices and pulps, and potatoes.

There are three basic types of spray dryers: (a) the pressure atomizing type in which the material is forced through nozzles forming a mist which is blown through heated air; (b) the cyclone type in which the material is sprayed into a whirling current of air in a tower or similar structure; and (c) the centrifugal disc type in which the material is dropped onto a rapidly revolving disc. The centrifugal force throws it from the disc in a fine mist.

Fig. 18 illustrates a typical spray dryer. Filtered, treated air is blown into the spray chamber through a number of openings in the center of which non-clogging nozzles are located. The material is preconcentrated in vacuum pans and pumped under high pressure to the nozzles. The resultant atomization is so complete and the turbulent action of the air and product particles so violent that the drying is practically instantaneous. The material drops to the floor and is collected in a suitable hopper. Any powder which is entrained in the discharge air is caught in a bag type dust collector with a continuous unloading device.

Atomization of the material in a spray dryer has the effect of making all the moisture "surface moisture," with the result that evaporation is rapid and almost instantaneous and the product remains substantially at the wet bulb temperature of the air. Because the product is immediately cooled to a point close to the wet bulb temperature, rather high inlet dry bulb temperatures can be used (300-350F). Spray dryers are so arranged that by the time the product is dried it is in a zone of comparatively cool air and, consequently, there is no damage due to overheating of the dried material.

### Drum Dryers

Drum dryers are designed to handle concentrated solutions, sludges and pastes. The material is fed onto the outer surface of a steam heated rotating drum usually made of stainless steel. A thin layer of the material is formed which dries rapidly and then is scraped off the drum by knife. The speed of the drum, thickness of the food layer, position of the knife, and temperature of the drum are all variables that can be regulated to suit various products. Some examples of foods dried by this method are bananas, tomatoes, potatoes, and milk. There are both single drum and double drum types, as illustrated in Figs. 15 and 17. All drum dried products are powdered, and therefore somewhat limited to certain products.

The Sardik dryer is a highly developed and extensively used adaptation of a drum drier. Fig. 13 and Fig. 16 illustrate this dryer which is particularly suited for processing highly hygroscopic and plastic food products. The dried material comes off the drum in the form of a thin sheet resembling crepe paper. The take-off room is air conditioned, principally because almost all foods so dried have a very rapid regain and must be ground and packed at a low humidity of approximately 35% (see later discussion on packaging of dehydrated foods). Moreover the conditioned supply air is introduced at a low temperature against the thin film as it comes off the drum, thereby immediately crystalizing the sugars in the product and rendering the material easier to handle.

# DRYER DESIGN

Although expansion in plant capacity for all types of drying is going forward the greatest shortage exists in the vegetable field. Relatively speaking, the products of spray dryers (milk and eggs) and of drum dryers have achieved a rather satisfactory rate of production. Since it is the production of vegetables in original cubed, or flaked, form that is far behind the demand, and since these can be satisfactorily produced in compartment and tunnel dryers, the Department of Agriculture is encouraging increased use of these dryers. Moreover, these dryers are comparatively simple to build, and the possibility of using substi-

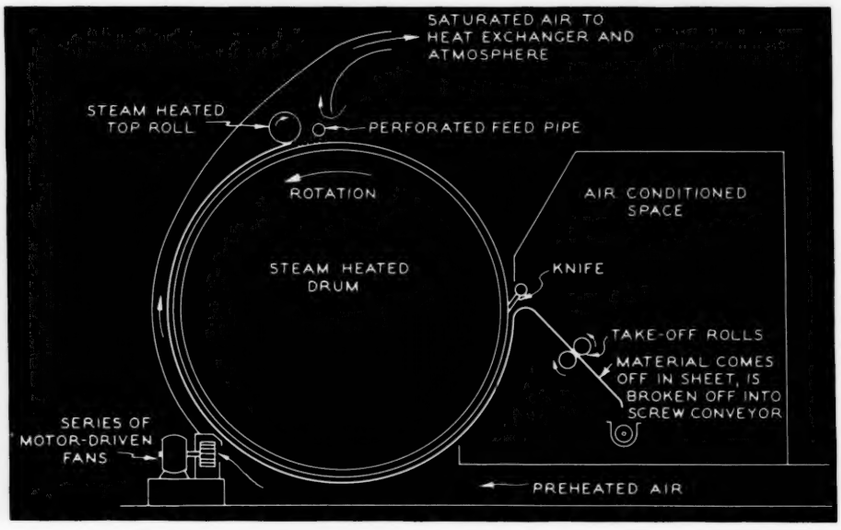



**Fig. 13. Schematic drawing of the drum-dryer developed by Sardik Food Products Corp. Also see Fig. 16, pages 46-47.**

tute material for metals is great. Resin-bonded plywood panels can be used for casings, wooden trays are possible, and so on. As stated previously, compartment dryers are mobile and will probably have a good salvage value after the war if the expected increased commercial demand for dehydrated food does not keep them busy. For all these reasons it seems desirable to concentrate on these dryers under present circumstances, and an attempt will be made to review the basic design principles.

The best source of heat for these types of dryers is undoubtedly steam. This is so because steam is always available (since it is required in the other food handling processes) and food dehydration is a low temperature operation that requires careful control.

As in all drying problems, data regarding temperatures, time, humidity, velocities, and rate of drying must be obtained by experiment or previous experience. Too much stress cannot be placed on experience.

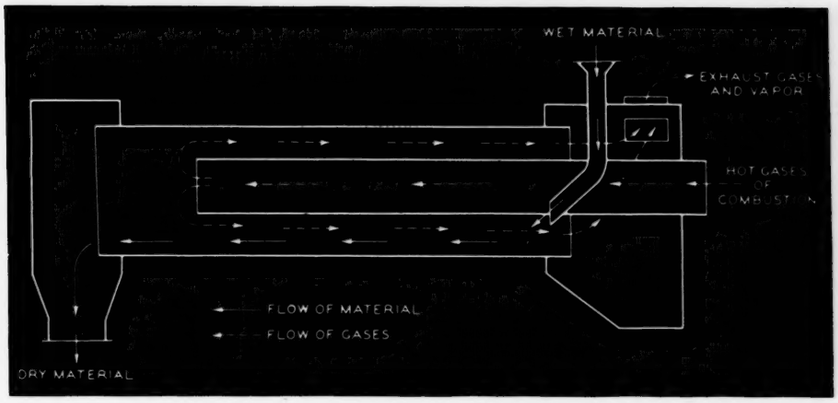



**Fig. 14. A direct indirect rotary dryer with hot gases passing through the center flue so as to extract the greatest possible heat before exhausting the air.**

There exists enough published data, however, to form some basis of design.

## Moisture Quantities

Tables 1 and 2 give the final moisture contents to which food must be dried. These are percents of moisture in dried products. The initial moisture content must be determined from experiment and, in the case of fruits and vegetables, can usually be taken from 85% to 95% on a wet basis. The difference in the weight bases may lead to confusion. For instance to reduce 100 lb of food from 90% moisture (wet basis) to 5% means the removal of 89.5 lb of water, not 85 lb. Chart 2 has been constructed to assist in easily determining the amount of water to be removed per pound of dried product when the initial moisture content is known on a wet basis and the final moisture content of the dried food is known. The capacities of dehydrators are usually stated in terms of pounds of final dried product.

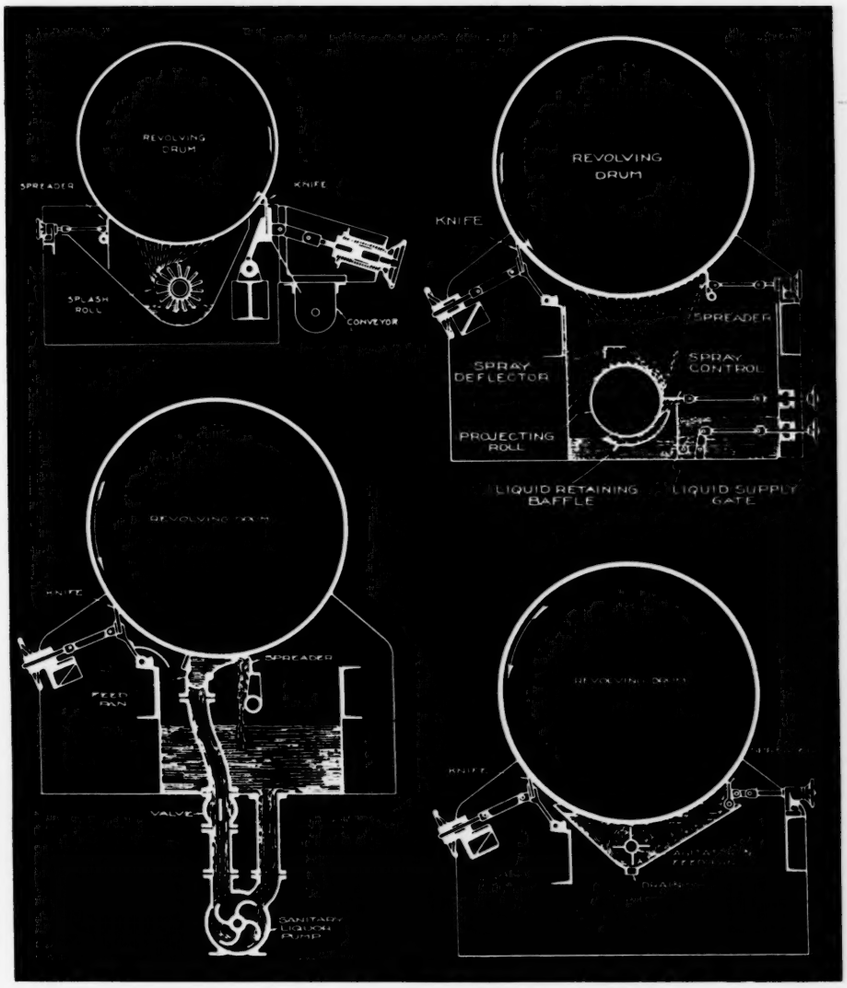
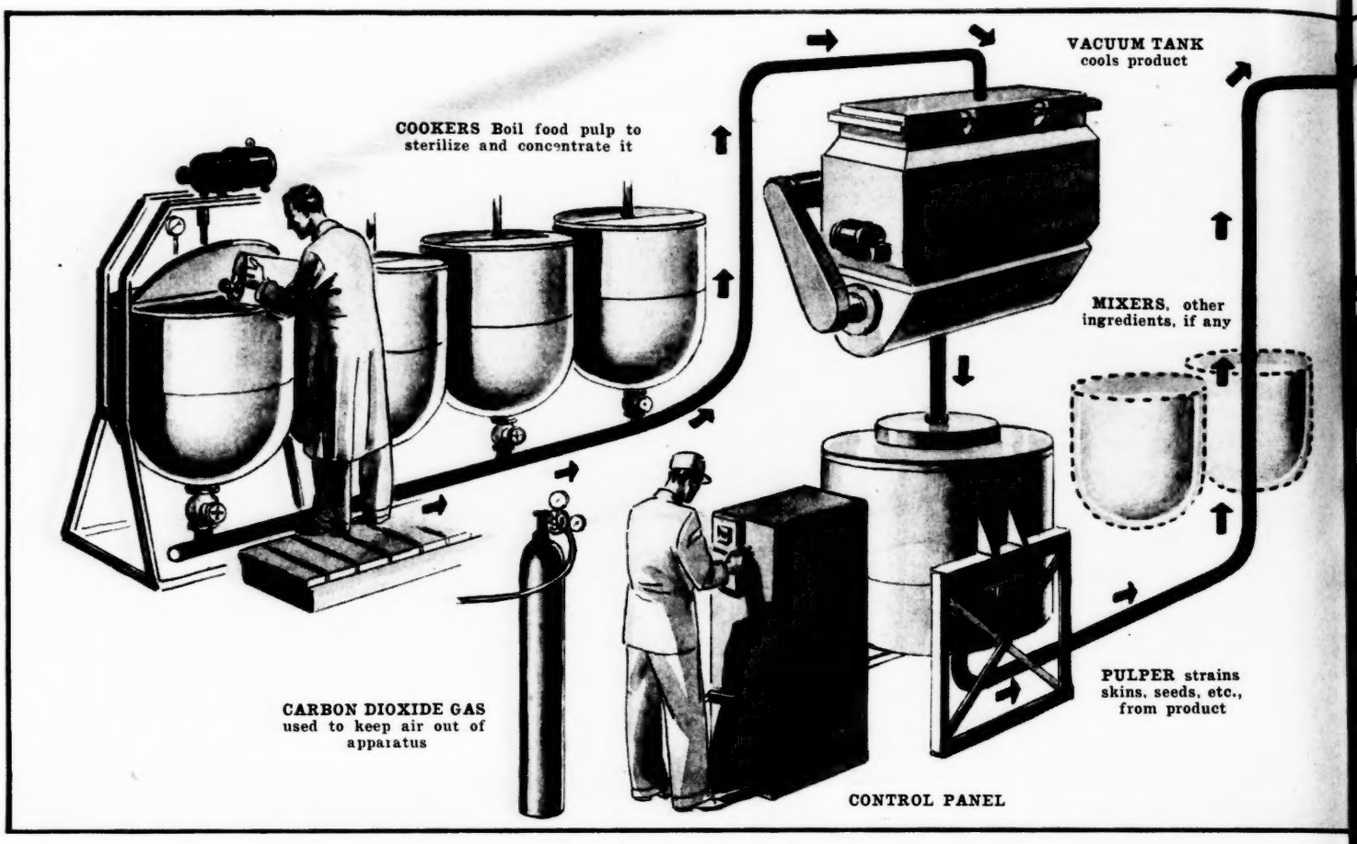



**Fig. 15. Four types of drum dryers: upper left, splash feed type; upper right, a patented spray film feed type; lower left, patented pan feed type; lower right, dip feed type. Drawings courtesy of Buffalo Foundry & Machine Company.**

## Tray Construction

Knowing the capacity in dried food for which the dryer is to be designed the weight of wet product to be handled can be calculated. The wet material should be spread evenly and not too thickly, the desirable loadings of the trays varying from ¾ lb per sq ft to 3 lb. Table 2 gives the recommended loadings for vegetables and fruits. Thus the required total tray area can be calculated.

The loading figures given in Table 2 will usually result in a layer of prepared food not much more than 1½ in. thick, so that on an average 2 in. high trays are suitable. The size of the individual trays should be such that they can be easily handled by one man; the maximum size of tray that one man can handle is usually considered to be 3 ft x 3 ft. Trucks of trays can vary in size depending on individual requirements, but usually they are constructed approximately 3 ft wide and 6 ft long. The height of the trucks should not exceed approximately 6 ft, because the average man cannot reach any higher than this to load the trucks. Experience has indicated that the open space be-




tween trays should be from 2 to 2½ in.

Considerable variability in details of tray design is permissible. The Department of Agriculture states that metal or wood trays having bottoms of No. 4 or No. 6 tinned hardware cloth are suitable. Stainless steel or monel metal would be most desirable but obviously they are not readily available at the present time. Galvanized trays are not recommended for fruits or acid

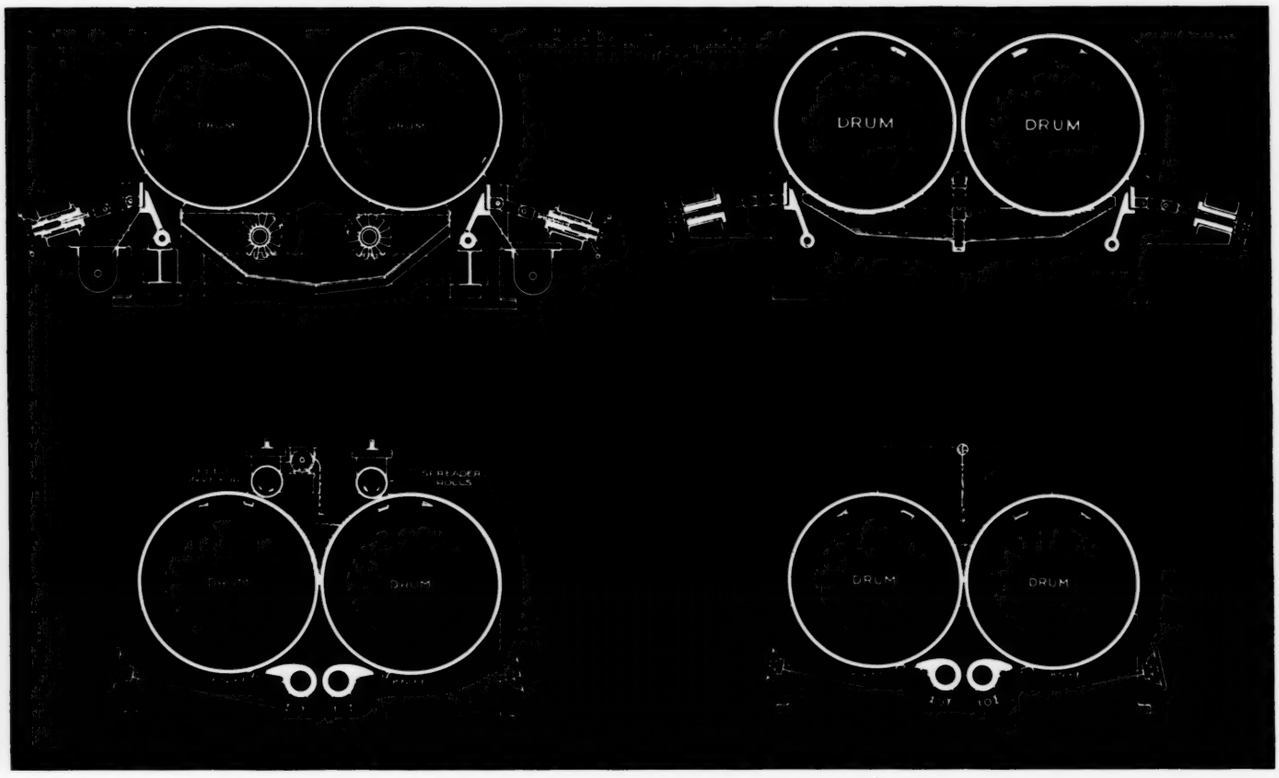



**Fig. 17. Four arrangements of twin drum dryers: upper left, splash feed type; upper right, dip feed type; lower left and lower right, two arrangements of center feed type. Drawings courtesy of Buffalo Foundry & Machine Co.**

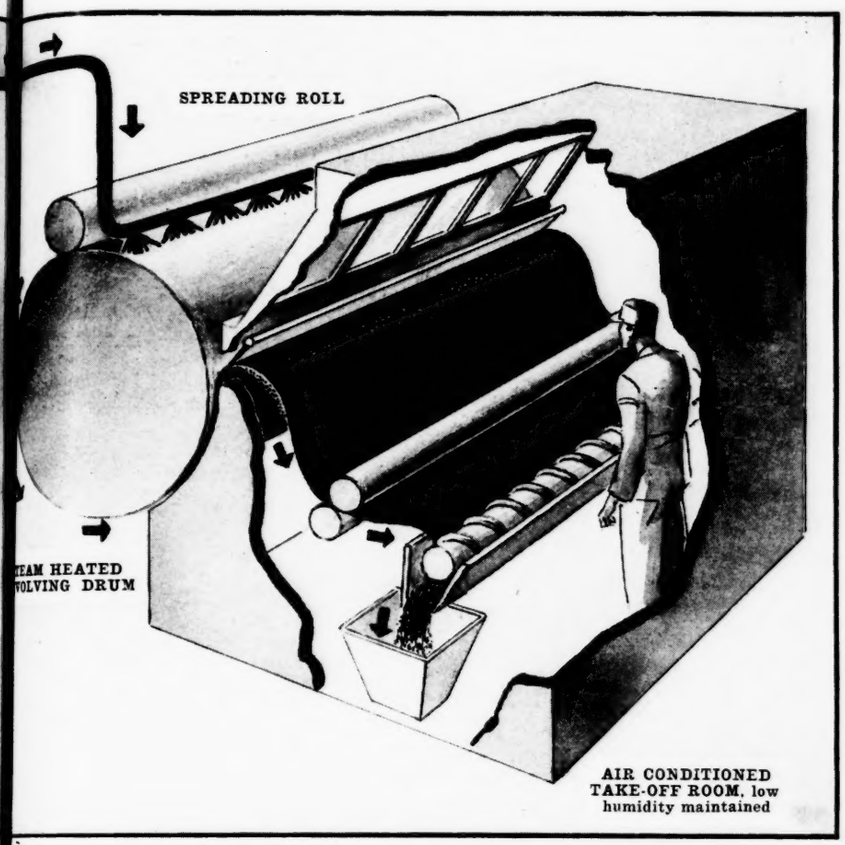



**Fig. 16. Flow diagram, not to scale, showing the dehydration process of the Sardik Food Products Corporation. Drawing from "Now It's Quick Dried Foods," by Alden P. Armagnac, in "Popular Science Monthly," reproduced by permission. Also see Fig. 13.**

vegetables, such as tomatoes. Some products tend to adhere to the perforated tray bottoms but this can be overcome by coating the trays with confectioner's slab oil (an edible mineral oil).

## Air Velocity

The higher the velocity the greater the drying rate during the initial stages of drying when free moisture is present (constant rate period). During the falling rate period of drying when only bound moisture is present velocity does not have an appreciable influence on the drying rate. Velocities from 500 ft per min to 1200 ft per min are commonly used, depending on the character and form of the product. Light, leafy vegetables tend to be blown away at high velocities. On the basis of experience a velocity of 800 ft per min is the recommendation for the average case. Naturally, it is of the utmost importance that there be even air distribution over the surface of the trays. Table 5 gives some interesting data on the effect of air velocity as determined by tests run by Christie and Matsumoto at the Fruit Products Laboratory of the University of California.

## Temperature

Temperatures used should be as high as is permissible without harming the material being dried. Tables 1 and 2 give the safe drying temperatures for various food products. During the early, constant rate period of drying higher temperatures can be used since the temperature of the material will be substantially at the wet bulb temperature of the air. Table 4 illustrates the effect of increasing temperature on the time of drying. Dry bulb temperature can be controlled by varying the steam input to the coil by means of a thermostat.

## Humidity

At constant temperature the lower the humidity of the air the more rapid will be the drying since the difference in vapor pressure between the moisture in the material and the air is increased. However, as stated previously, the humidity must be controlled (by variation of outside air admitted) so that the moisture is not carried away from the surface faster than it progresses from the interior to the surface.

It is common practice to close outside air dampers on compartment dryers at the initial stage of drying so that the material is quickly brought up to temperature at practically 100% relative humidity. After the material is up to temperature, the actual drying can be started by progressively lowering the humidity. The tendency for case hardening is thereby minimized. The proper humidity to carry at various stages of the drying is a characteristic of the material and can only be determined by actual test and experience.

## Air Quantities

The moisture evaporated from the food within the dryer is removed by admitting outside air which increases in humidity as it progresses through the dryer and is then discharged. The quantity of this outside air is not necessarily constant (see previous discussion) and neither is its temperature and humidity leaving the dryer. The entering air is usually at a constant condition of temperature and humidity during a drying period but since the leaving condition varies, the amount of air required to accomplish a definite amount of moisture removal cannot be easily estimated except on the

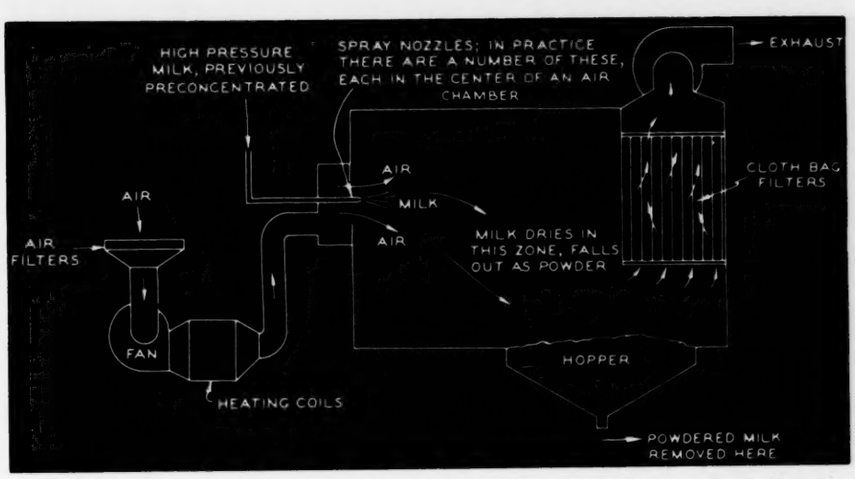



**Fig. 18. Schematic drawing, not to scale, showing a spray dryer of the pressure-spray rotary type and its application to the drying of milk.**

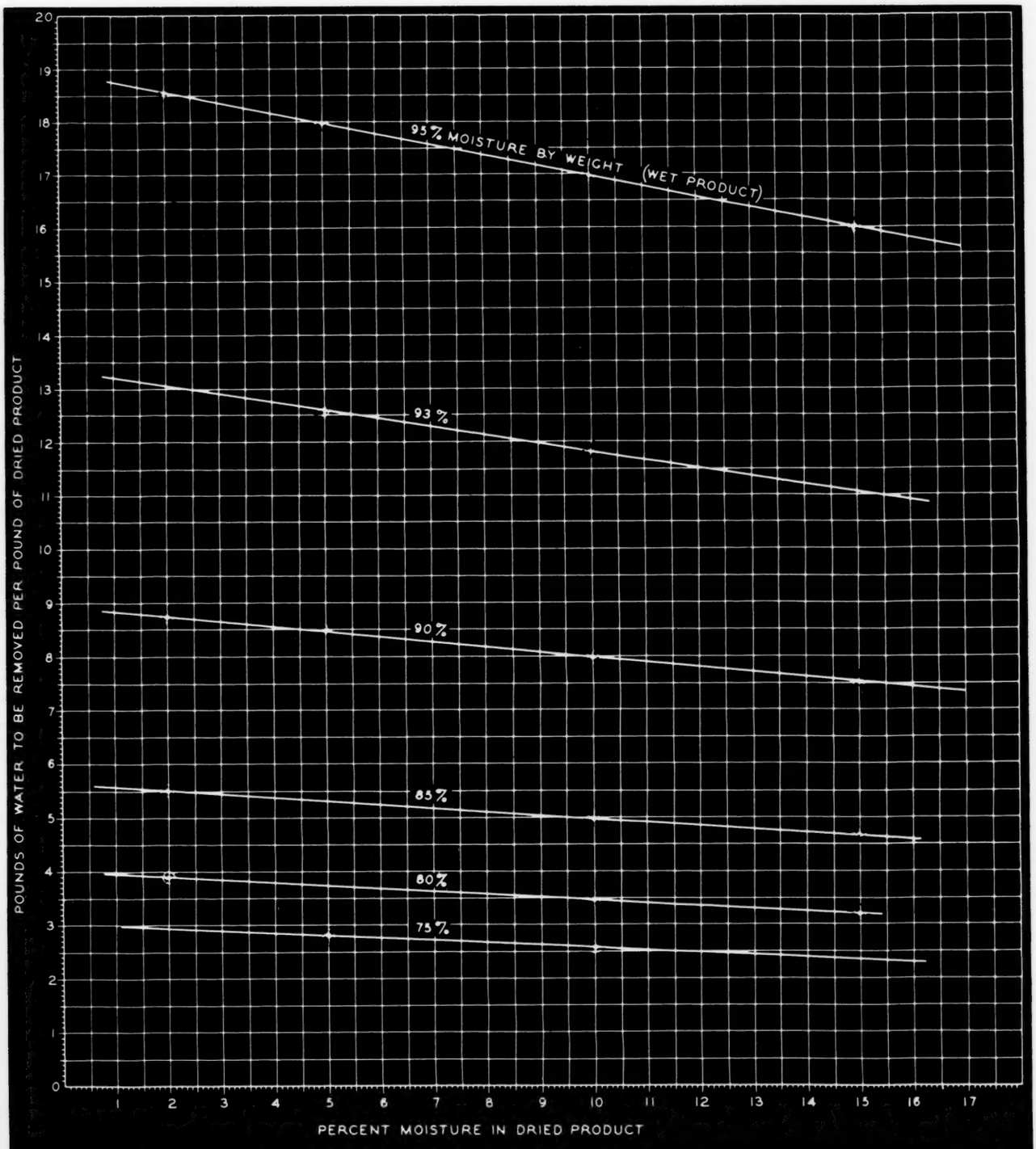



Chart 2. To determine quantity of moisture to be removed from a wet product to obtain a dried product with a predetermined moisture content, enter horizontal scale, percent moisture in dried product, move vertically to curve of percent moisture in wet product, thence to the left to the result in pounds of water to be removed per pound of dried product. Example: How much wet product with 90% moisture content is required to produce 1 lb. of dry material with 5% moisture? Solution: Enter lower scale at 5%, move vertically to the 90% curve, thence to the left and read 8.5 lb. of water removed per pound of dried product. The 8.5 plus the 1 lb. dried product gives 9.5 lb. of wet material required. CAUTION: Always add the 1 lb. of dried material to the figure obtained from the chart.

basis of experience. Indications are, however, that with a food dryer constructed along the lines suggested above the average leaving relative humidity will be about 60%. Assuming an average leaving dry bulb temperature of 150F it can be found by referring to a psychrometric chart that the leaving air will carry about 0.125 lb of moisture per pound of air. Assuming an average entering air condition of 70F D.B. and 50% R.H., the initial moisture content of the air is about 0.008 lb per lb of dry air. Hence, the moisture removed per pound of air is 0.117 lb. Since the total amount of moisture to be removed is known, the total amount of outside air required during the drying period can be roughly approximated. In the case of a tunnel dryer, the rate of introduction of outside air does not vary but remains constant once equilibrium is established. The outside air quantity is similarly calculated by assuming the inlet air condition and estimating the leaving condition on the basis of previous experience.

The total quantity of air to be circulated (outside plus recirculated) should be such that the velocity of air through the dryer between the

trays is maintained at the recommended levels.

## Heat

The heat required during the drying period in the case of a compartment dryer is made up of (a) heat required to raise the food to the drying temperature; (b) latent heat of vaporization of water to be removed; (c) sensible heat lost in the discharged air; and (d) total radiation and conduction losses.

These four items are calculable by standard familiar methods and thus the total amount of heat required to produce a given quantity of dried food can be estimated. But it should be clear that the *rate* of heat input at any particular time cannot be predicted accurately except from experience.

In the case of a tunnel dryer once equilibrium is established the heat input is substantially constant and the heat needed per unit of time can be estimated by the formula which follows (symbols below and right):

Let $T_1$ = temperature of makeup air (room temperature), F;
$T_2$ = temperature of air leaving dryer, F;
$t_1$ = temperature of stock entering dryer, F;
$t_2$ = temperature of stock leaving dryer, F;
$t_t$ = temperature of cars, trays, or conveyor entering dryer, F;
$S_1$ = specific heat of the bone-dry stock, Btu per lb per F (use 0.2);
$S_2$ = specific heat of cars, trays, or conveyor, Btu per lb per F;
$S_3$ = specific heat of vapor in air (superheated), Btu per lb per F (use 0.45);
$H_1$ = total heat of air-steam mixture entering dryer, Btu per lb of dry air;
$H_2$ = total heat of air-steam mixture leaving dryer, Btu;
D = weight of stock, bone dry, in dryer per unit of time;
$W_1$ = weight of water per pound of bone-dry stock entering dryer, lb per lb;
$W_2$ = weight of water per pound of bone-dry stock leaving dryer, lb per lb;
l = latent heat of evaporation at $t_2$, Btu per lb;
P = weight of dry air entering dryer per unit of time, lb;
A = area of dryer enclosure, sq ft;
U = heat transmission coefficient of enclosure, Btu per sq ft per F per unit of time; and
C = weight of cars, trays or conveyor entering dryer per unit of time

Then the heat necessary to heat the bone-dry stock and the water in the stock as it leaves the dryer to the leaving-dryer temperature is

$$Q_1 = D\ (S_1 + W_2)\ (t_2 - t_1)$$

The heat required to evaporate the water from the stock consists of the heat to raise the water to be evaporated from the temperature of the stock to the temperature of evaporation (assumed at the temperature of the stock leaving the dryer), the heat of evaporation, and the heat to raise the temperature of the vapor to that of the air leaving the dryer, so that

$$Q_2 = D\ (W_1 - W_2)\ [t_2 - t_1 + l + S_3\ (T_2 - t_2)]$$

To raise the temperature of the air supplied to the dryer heat is needed, and

$$Q_3 = P\ (H_2 - H_1)$$

Transmission losses through the dryer enclosure can be stated as:

$$Q_4 = \left[\left(\frac{T_1 + T_2}{2}\right) - T_1\right] UA$$

Heat is required to raise the temperature of the equipment such as cars, trays, or conveyors, and this can be figured as:

$$Q_5 = CS_2\ (t_2 - t_t)$$

Finally. the total heat required is:

$$Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$$

Because foods must be dried at comparatively low temperatures it is apparent that the drying rate (which is related to the quantity and condition of outside air introduced to the dryer) may be highly dependent on atmospheric humidity. The lower the drying temperature the more pronounced is this dependency. It is generally agreed that food drying temperatures lower than those given in Tables 1 and 2 are desirable, provided that the drying time is not increased, since at the lower temperatures there would be better flavor, odor, and vitamin retention.

If a closed system of drying were used incorporating a suitable dehumidifier through which the air was recirculated, complete independence of atmosphere conditions and lower drying temperatures could be obtained. Besides, oxidation of the food would be minimized. Absorptive dehumidifying systems (such as silica gel) would be most suitable for this purpose, since the latent heat released by the absorption of moisture in the dehumidifier (and which is reflected in elevated dry bulb leaving the dehumidifier) would complement the latent heat of vaporization required to evaporate the moisture from the food.

This idea is being tried experimentally at the present time, and whereas it should result in a more uniform, higher quality product, it remains to be seen whether it can be qualified economically in view of its greatly increased cost. Another point to be considered is that the final moisture contents considered satisfactory now (see Tables 1 and 2) may have to be lowered in the interest of larger storage life. Since these moisture contents just about represent the limitations of presently used hot air dryers it may become necessary in the future to subject some products to an additional drying operation in apparatus incorporating a means of dehumidification.

TABLE 3. REPRESENTATIVE FOODS FOR AIR DRYING AND CONDITIONS TO BE MET

(From "Drying Foods with Non-Rotary Air Dryers," by Birney Miller, *Food Industries* (McGraw-Hill Pub. Co.), April, 1936)

| Product | Moisture, Per Cent: Before Drying, Wet Weight Basis | Moisture, Per Cent: After Drying, Commercial Dry Basis | Drying Time, Min | Drying Temp., F |
|---|---|---|---|---|
| Casein | 50 to 60 | 6 to 10 | 17-38 | 130-200 |
| Dessert Powder[1] | 3 to 4 | 0 | 90-300 | 110 |
| Breakfast Cereal | 27 | 1 | 240 | 240 |
| Peppers | 78 | 5 | 12-26 | 190 |
| Grated Cheese | 35 | 18 | 70 | 110 |
| Coconut | 21 to 27 | 6 | 40 | 100-140 |

[1]Time is different for each flavor.

# PACKAGING

The packaging of dehydrated foods is a very important phase of the entire process. In fact, improper packaging can ruin the results of even the best, and most careful application, of dehydrating technique. Packaging involves consideration of numerous factors such as fumigation, bacterial deterioration, insect infestation, shipping procedures, and light absorption, all of which are outside the scope of the field of heating and air conditioning. Nevertheless, the air conditioning engineer

is vitally concerned with the atmospheric conditions surrounding the packaging process. Note the following:

"Dehydrated vegetables must be packed in suitable containers which are moisture-proof, moisture-vapor-proof, and insect-proof. Precautions should be taken that the product is not insect-infested before being put in the containers. *For best results, the packaging should be done within a reasonable time in a room with low relative humidity, free from dust, and separate from the operating part of the plant.* Five-gallon, friction-top tin cans which are spot soldered are ordinarily used as containers for dried vegetables. Moisture-proof paper containers are being developed for the packaging of these products.

"In order to prevent insect-infestation, and especially the deposition of insect eggs on the dried products, the packing room and the packages must be kept scrupulously clean, and fumigated if necessary. As an additional precaution, the products may be heated to 135F for a few minutes immediately before packing. All packages should be given the same treatment, or otherwise fumigated immediately before filling. Packages must be closed directly after filling.

"Army specifications require that certain dehydrated vegetables must be packed under an inert gas, such as carbon dioxide or nitrogen."†

The tin can seems to be the perfect method for packing dehydrated foods and whereas this means the use of a vital metal it should be remembered that on the average 1 can of dehydrated food is equivalent to 10 cans of equal size of other foods. As noted, many containers have been developed using various non-metallic synthetic materials, such as laminated cellophane, kraft paper, etc., and many items in which the regain of moisture is not too serious have been successfully packaged with them. For example large quantities of powdered eggs are being shipped to England in 200 lb barrels with a double, crinkled, wax-saturated, kraft-paper liner.

The importance of maintaining a low relative humidity in the packaging room (to prevent regain) will vary not only with the product but with the final form of the product. Powdered vegetables and fruits such as tomatoes and bananas are particularly susceptible to rapid regain.‡ The method of packaging is also a factor. For example bouillon cubes which contain a lot of salt are individually wrapped in cellophane. Humid weather raises havoc with the compressing and wrapping operations.

Naturally, the proper conditions to be maintained in the packaging room depends on the desired percentage of moisture in the material and its regain characteristics. However, it has been found that in most cases a temperature of 75F to 80F with relative humidities of 30% to 35% is satisfactory. Most of the air conditioning systems now installed for dehydrated food packaging have been of the type utilizing independent dehumidification with adsorption apparatus such as the silica gel dehydrator. Typically, such systems utilize the adsorption machine to take care of the entire latent load, and the sensible load is handled by conventional compression refrigeration apparatus. These split systems are favored because:

(1) The maintained dew point is low, resulting in a comparatively large latent load;

(2) The stress is on holding a low relative humidity. Temperature control is of secondary importance; and

(3) Operating costs tend to be low because heat (steam or gas) for activation of the desiccant is usually available at low cost since large quantities of heat are used for other processes.

In some cases it has been noted that the maintained dew point and the latent load are such that there would be danger of frosting of coils if refrigeration only (with reheat for control) were used for dehumidification.

It should be noted that the literature on this subject is growing rapidly and current trade periodicals should be consulted. For a fairly detailed bibliography on the subject reference should be made to Circular 619, U. S. Department of Agriculture, obtainable from the Superintendent of Documents, Washington, D. C., for ten cents. In addition, the reader is referred to "Elements of Chemical Engineering," Badger and McCabe; various articles in *Food Industries*, particularly "Dehydration Looks Up" (L. V. Burton, September 1941) and "Dehydration Equipment as Applied to Food Processes" (Francis Rosseau, Dec. 1939); and various papers in the Transactions of the American Society of Heating and Ventilating Engineers.

It is hoped that this Reference Section has indicated the importance of food dehydration to this as well as other countries, and the part played in this new art by developments in heating and air conditioning. It is quite possible that the day may come when food dehydration will be one of the major branches of the broad field of heating, ventilating and air conditioning.

TABLE 4.—RELATION OF TEMPERATURE TO RATE OF DEHYDRATION —AIR VELOCITY 500 FT. PER MIN.

(From "Study of Air Velocity and Temperature in Vegetable Dehydration," by Christie and Matsumoto. Reproduced by permission from the ASHVE Journal, Vol. 33, June, 1927.)

| Temperature, F | | Carrots | | Cabbages | | Peas | |
|---|---|---|---|---|---|---|---|
| Dry Bulb | Wet Bulb | Hours to Dry | % of Weight Lost | Hours to Dry | % of Weight Lost | Hours to Dry | % of Weight Lost |
| 120 | 76 | 7.0 | 83.8 | — | — | — | — |
| 130 | 82 | 6.3 | 83.3 | 5.0 | 93.0 | 5.5 | 70.8 |
| 140 | 85 | 5.0 | 83.0 | — | — | — | — |
| 150 | 88 | — | — | 4.5 | 92.0 | 5.0 | 69.0 |
| 160 | 94 | 4.0 | 83.0 | 4.0 | 92.0 | 3.3 | 71.2 |
| 180 | 100 | 3.5 | 83.7 | 2.7 | 92.4 | 3.0 | 71.0 |

TABLE 5.—RELATION OF AIR VELOCITY TO RATE OF DEHYDRATION AIR TEMPERATURE 160F

(From "Study of Air Velocity and Temperature in Vegetable Dehydration," by Christie and Matsumoto. Reproduced by permission from the ASHVE Journal, Vol. 33, June, 1927.)

| Air Velocity, Ft. per Min. | Carrots | | Cabbages | | Peas | |
|---|---|---|---|---|---|---|
| | Hours to Dry | % of Weight Lost | Hours to Dry | % of Weight Lost | Hours to Dry | % of Weight Lost |
| 250 | 5.3 | 83.7 | 5.5 | 91.8 | 4.7 | 71.2 |
| 500 | 4.0 | 83.0 | 4.0 | 92.0 | 3.3 | 71.2 |
| 750 | 3.5 | 83.0 | 3.5 | 90.0 | 2.6 | 71.3 |
| 1000 | 3.0 | 82.8 | 3.2 | 91.0 | 2.0 | 71.0 |

†Statement by the Dehydration Committee, Bureau of Agricultural Chemistry and Engineering.

‡See "Food Concentrates," Heating and Ventilating, page 76, January, 1942.

# How to Assure Safe Operation of Low-Pressure Heating Boilers

By ARTHUR F. NORCROSS

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THERE are three fundamental rules for obtaining proper heating with steam; first, there must be steam pressure at the source of supply; second, there must be free return of the water of condensation, and third, there must be free relief of the entrained air.

In the past, as these points became more generally understood, developments in the utilization of steam as a heating medium brought improvements in distribution methods, from which the one-pipe steam system with automatic air valves was a step forward. Then the Paul system, which was an improvement applied to the one-pipe system, was developed. This system consisted of expansion-type air-valves connected by air line piping to a steam siphon, air or hydraulic ejector, for quick relief of entrained air. From this system was developed the present-day system of radiator traps with vacuum return lines for air and condensation relief. Mention is made of these stages of development to show that the trend was toward the use of lower steam pressures.

It was natural that improvements in boiler and radiator designs should follow the same trend, so that today an important part of the heating industry is the manufacture and installation of low pressure steam heating systems.

The present practice, therefore, in providing for heating equipment in buildings where fuel must be burned, is to install low pressure boilers; the assumption is that such equipment is safe although records show that many accidents have been caused by failures of low pressure boilers in operation.

Low pressure boilers include steam boilers operating with an internal pressure of 15 lb per square inch and water boilers operating at 30 lb or less.

The files of boiler insurance companies and newspapers show that accidents in the operation of these low pressure boilers have produced or contributed to casualties of the following type: Scalding by steam or hot water; burns due to back fires; injuries to persons from contact with fragments of exploding boilers, or as a result of such explosion; property damage, and, carbon monoxide poisoning.

Many accidents to boilers occur during the coldest weather and the resulting inconvenience to the occupants of the building, who may be left without heat, is a condition which all building owners are anxious to avoid. Such accidents no doubt could have been prevented.

However, there is no question that low pressure boilers are safe to use if they are properly manufactured, installed and operated.

## Manufacture

Some of the unsafe conditions that were found in the early makes of boilers were due to faults in the material or methods of manufacture, and in order to reach the state of near perfection such as exists today in the production of low pressure boilers, manufacturers realized the necessity of employing research and engineering staffs as a part of their organization. Some of the conditions which were found to be unsafe will be recognized in the following:

*In steel boilers:* Undiscernible flaws in the metal; imperfect riveting; imperfect stay-bolting, or insufficient number of stay-bolts; and fatigue of metal due to expansion and contraction strains.

*In cast iron boilers:* Sand holes and blow holes; cold shot metal; unequal thickness of section walls due to shifting of core while casting; core rods and sand left in castings; crystallization of the iron; strains due to sluggish circulation of boiler water or to mud or scale accumulations at low points; strains due to improper assembly; and lack of uniformity in machining and tapping pipe and nipple openings, thus producing strains when assembled.

The application of research and engineering investigation in the manufacturing of low pressure boilers was productive in accomplishing results, the principal ones being: Improvement in designs to give free circulation of boiler water with the maximum absorption of heat from the fire and gas surfaces; adaptability to the use of coal, oil or gas as fuel; accessibility for cleaning of fire and water surfaces; protection afforded by the use of safety appliances; and uniformity of quality of material and workmanship.

Application of the findings obtained by laboratory investigations and analyses, use of electric welding, use of x-rays in examination of metal, use of jigs and templates in improved machine shop practice, as well as many other factors, have enabled the manufacturers of today to turn out an improved product. The final step in production today is the inspection and test of the finished product made by the testing department under the supervision of experts.

The most important consideration in the purchase of a boiler is the selection of a manufacturer whose reputation for integrity and reliability has been established. Then, knowing the type of system and kind of fuel that is to be used, and having the data available for the requirements of the building to be served, the selection of a boiler of proper capacity and type becomes a simple matter.

In the case of conversion, assume that a boiler has

been in use for several years burning solid fuel under natural draft. This boiler may have been designed with 60% of the heating surface built into combustion chamber walls and crown sheet and 40% in the flue passages. The conversion of this boiler to oil or stoker firing, where the heat of combustion in the gases is accelerated through the boiler, may cause failure due to overheating in the flue passages, with the consequent creation of undue expansion strains in the metal. To meet this situation, manufacturers now design boilers for oil or stoker operation with the combustion chamber surfaces and flue passages designed in the proper ratio for maximum heat absorption without undue strains being set up.

It may be desirable, therefore, when considering a change from coal firing to oil or stoker firing, to scrap the old boiler and purchase a new boiler that is adapted for the burner equipment. Consultation with a heating engineer may earn dividends for the purchaser by obtaining economy in operation as well as freedom from troublesome repairs or damage later on.

To sum up, it is a conservative statement that any low pressure boiler leaving a manufacturer's plant today is safe for operation in the service for which it was designed, provided that the details of installation and operation, hereafter mentioned, are observed and followed.

### Installation

However, improper installation of a perfectly constructed boiler can nullify all the features that the boiler was expected to have and can even turn the equipment into a hazard.

Consequently it is just as important to select a heating contractor of established reliability as it is to deal with a reliable manufacturer. It is false economy to have a fine installation left incomplete or faulty because of ignorance or carelessness of workmen.

The location of a boiler should be given thoughtful consideration. It should be located as near to the smokestack as is possible. It should be located at an elevation that will provide a proper differential between the water line of the boiler and the lowest drip points of the heating mains and risers. It should be so located that access for proper cleaning of internal and external surfaces is easy and so that future repairs can be made. Return tubular boilers have been so installed that tube replacements are impossible. Boilers have been installed in pits in such a manner that cleanout doors, handholes, or return lines have been inaccessible for proper maintenance and care in operation.

The foundation for a boiler setting should be ample in area and of proper construction to withstand settlement. Bear in mind that a boiler is connected to the heating system by rigid piping and any excess strain such as might be caused by a settlement may cause a sudden break in some fitting or in the boiler itself, while the boiler is under pressure. We know that boiling water under pressure is a source of energy and if this pressure is suddenly released, a certain percentage of this boiling water will flash into steam, liberating this energy suddenly, equivalent to an explosion. Take for instance a boiler containing 30 gallons of water under 10 lb steam pressure by gauge. Reference to steam tables will show that sudden release of this 10 lb pressure on 30 gallons of water would allow 2.8% of the water to flash into steam with the consequent availability of nearly 500,000 ft lb of energy—equivalent to approximately ½ lb of black powder in energy. This indicates the need for precaution in all details of installation, including the assembly, of cast iron sectional boilers. The detailed instructions which are issued by the manufacturer for erection of their make of boiler should be followed by the installing contractor in detail. Many a new sectional boiler has cracked a section when put into operation because the tie rods were not slacked off after assembly or because other similar detailed instructions were not followed. Sectional boilers have been found where the sections had not been drawn together sufficiently during installation.

Many a boiler is installed and enclosed in a boiler room without consideration having been given to the question of air supply necessary to support proper combustion. To burn one pound of fuel oil requires approximately 200 cu ft of air and to burn one pound of coal a somewhat larger volume of air is necessary. The carbon in the coal or oil will burn to carbon monoxide if the supply of free oxygen is restricted. Therefore, it is essential to have a sufficient supply of air to allow the CO to be burned to $CO_2$. It is most important that the chimney and breeching should be of ample and specified size and should be mechanically tight at all joints to reduce air infiltration. Proper cleanout doors should be provided so that the chimney and breeching may be kept free from soot accumulation. The top of the stack should be extended above, or otherwise located as remotely as possible from adjacent structures, so that back draft due to reflected air pressure is minimized. Inattention to these provisions has been the cause of many fatalities. Sudden back drafts have caused burns. Insufficient draft, or insufficient air supply, creating the formation of carbon monoxide, has caused fatalities because of defects in breeching or chimney walls, or because of uncemented joints in sectional boilers. These defects have allowed carbon monoxide, where present, to escape into the building instead of being exhausted up the chimney as intended. There are other contributing causes of carbon monoxide poisoning, such as improper banking of fires, for example.

Piping of steam, water and return lines requires its share of careful attention. Control valves on steam mains, water lines, return lines and blow-off lines should all be in an accessible location.

Globe valves should never be installed on blow down lines. Plug cocks, gate valves, or other type of full opening shutoffs must be used.

Insufficient size of blow-off or drain outlets is one of the principal defects in design that still exists in many cases. Properly designed drain openings are often insufficiently equipped by the installing contractor. It is recommended that full size drain valves be utilized on all drain openings where such conditions exist at present.

The steam pipe connection to the top of a water column must be free from any low points, otherwise

a water pocket will create a false water level in the gauge glass.

Piping should never be installed in a manner to prevent opening of flue cleanout doors or prevent access to handholes or manholes. Within the past year, the writer has encountered two instances where cleanout doors could not be opened until obstructing pipes were re-located.

Installation of return piping in a manner known as the Hartford loop will eliminate the use of check valves and will assure the maintenance of an even water level in the boiler.

### Operation

Assuming that a low pressure boiler installation has been completed in a manner to provide safe operation, nevertheless much can happen in the manner of its operation to cause an accident which nullifies all the safety precautions taken by the manufacturer and installer. The human elements of ignorance, carelessness or neglect are the factors contributing in some manner to practically all accidents in boiler operation. Many a building owner installs semi-automatic or fully automatic equipment, or operates a manual fired coal boiler by engaging a part-time janitor. In either case, the boiler attendant is expected to perform so many other duties that careful attention to the duties in connection with the safety of operation of the boiler is often neglected.

Much has been published concerning rules for the safe operation of all types of boilers, fuel burning equipment, controls, safety devices and other related accessories. However, unless the boiler room operator is thoroughly familiar with these rules and realizes the importance of following them, the safe and continuous functioning of the boiler plant is endangered.

In conclusion, the surest way to obtain safe operation of boiler plants is to ascertain the proper equipment from consultation with a qualified engineer; buy it from an established manufacturer; have it installed by a reliable contractor; and lastly, operate it under the supervision of a responsible engineer.

# Air Sterilization

During the last few years a number of investigators in France, England, and the United States have been studying the possibilities of sterilizing air by means of germicidal mists. It was found that when germicidal agents were dispersed in the air in the form of extremely small drops, the bactericidal agent is able to act more effectively on the bacteria suspended in air. A theoretical explanation for the high bactericidal activity is that since each droplet contains the same concentration of effective chemical substance as does the parent solution, the bactericidal agent is able to act in high concentration on the air-borne bacteria.

English investigators found that resorcinal and hexyl resorcinal were effective and in the amounts employed for air sterilization they are harmless to the human body. However, both of these substances possess a certain amount of toxicity and there is little information available on the effects of breathing these substances over a long period of time.

In this experiment, reported some months ago in an issue of *Science*, the investigators studied the possibility of using compounds with marked wetting and spreading properties, such as anti-bacterial detergents. They also studied the possibility of using propylene glycol and the related glycols as bactericidal agents. Most of the experiments were conducted with propylene glycol and a few very closely related substances such as trimethylene glycol and ethylene glycol. Propylene glycol was used because of its extremely low toxicity.

The studies were made by spraying known quantities of bacteria into a rectangular glass-walled chamber of 60 liters cubic capacity. The air was gently agitated by means of a slowly rotating rubber bladed fan. The number of bacteria recoverable from the chamber air was determined by withdrawing a measured volume of air at a constant rate through a glass funnel which was suspended directly above the surface of an agar plate within a sealed glass jar. Two identical chambers were used for the experiment, one for the test and the other for the control. The control chamber was necessary because there is a progressive and quite constant diminution in the number of colonies recovered from successive air samples taken during the period of an hour.

The microorganisms employed were pathogenic invaders of the respiratory tract, e.g., pneumococci Types I and III, hemolytic streptococci and hemolytic staphylococci, as well as organisms of lesser or no pathogenicity, such as Streptococcus viridans, B. coli and Micrococcus catarrhalis. In the experiments the substance, such as propylene glycol, was sprayed into the atmosphere with an atomizer which produced a very fine mist. It was found that one part by weight of propylene glycol in two million volumes of air effected complete sterilization, containing as many as 200,000 bacteria per cubic liter of air. Investigators reported that this action occurred with surprising rapidity. Air samples taken after a few seconds after the introduction of the propylene glycol showed that complete sterilization had been obtained. It was also found that bacteria sprayed into the chamber containing the germicidal mist were killed with equal rapidity.

Tests also made with other glycols showed that ethylene glycol and trimethylene glycol were about as effective as propylene glycol. Glycerine, on the other hand, exhibited only slight killing action.

The investigators pointed out that germicidal action of propylene glycol mist appears to be of brief duration. However, they found that the bactericidal effect may be prolonged for at least 90 minutes by the addition of small quantities of glycerine. A further study is being made on this as well as on the physical properties of the germicidal mist, the minimum effective concentration and the activity of other compounds. The investigators are also observing the effect on the lungs of animals breathing these atmospheres.

# Degree-Days for October, 1942

HEATING AND VENTILATING'S 15th year of publication of monthly degree-day data

| City | Monthly Degree-Days | | | Cumulative Degree-Days | | | Year[1] |
|---|---|---|---|---|---|---|---|
| | Degree-Days, Oct., 1942 | Degree-Days, Oct., 1941 | Degree-Days, Oct., Normal | Season, 9/1/42-10/31/42 | Season, 9/1/41-10/31/41 | Season, Normal 9/1-10/30 | Normal, 9/1-6/30 |
| Abilene, Tex. | 106 | 87 | 0 | 125 | 0 | 0 | 2061 |
| Albany, N. Y. | 420 | 435 | 446 | 592 | 563 | 518 | 6580 |
| Albuquerque, N. Mex. | 228 | 262 | 273 | 244 | 313 | 273 | 4298 |
| Alpena, Mich. | 525 | 486 | 570 | 798 | 668 | 792 | 8299* |
| Anaconda, Mont. | 611 | 702 | 647 | 874 | 1215 | 982 | 8357** |
| Asheville, N. C. | 236 | 138 | 276 | 322 | 149 | 276 | 4232 |
| Atlanta, Ga. | 81 | 44 | 96 | 118 | 44 | 96 | 2890 |
| Atlantic City, N. J. | 170 | 170 | 254 | 236 | 193 | 254 | 5176 |
| Augusta, Ga. | 41 | 16 | 16 | 59 | 16 | 16 | 2161 |
| Baker, Ore. | 491 | 589 | 552 | 678 | 977 | 810 | 7163 |
| Baltimore, Md. | 149 | 134 | 223 | 199 | 142 | 223 | 4533 |
| Billings, Mont. | 448 | 589 | 524 | 684 | 925 | 713 | 7119 |
| Binghamton, N. Y. | 371 | 365 | 453 | 528 | 478 | 561 | 6808 |
| Birmingham, Ala. | 70 | 24 | 0 | 105 | 24 | 0 | 2352 |
| Bismarck, N. D. | 555 | 601 | 626 | 906 | 881 | 848 | 9192 |
| Block Island, R. I. | 278 | 274 | 279 | 369 | 344 | 279 | 5788 |
| Boise, Idaho | 401 | 434 | 434 | 507 | 657 | 536 | 5552 |
| Boston, Mass. | 288 | 299 | 363 | 391 | 388 | 411 | 6045 |
| Bozeman, Mont. | 586 | 689 | 651 | 883 | 1163 | 987 | 8521** |
| Buffalo, N. Y. | 367 | 382 | 419 | 521 | 455 | 494 | 6822 |
| Burlington, Vt. | 488 | 560 | 481 | 711 | 762 | 625 | 7514 |
| Butte, Mont. | 703 | 787 | 655 | 1038 | 1338 | 999 | 8272 |
| Cairo, Ill. | 143 | 97 | 158 | 217 | 104 | 158 | 3909 |
| Canton, N. Y. | 461 | 549 | 557 | 691 | 745 | 746 | 8020 |
| Charles City, Iowa | 443 | 396 | 476 | 704 | 513 | 569 | 7588 |
| Charleston, S. C. | 21 | 0 | 0 | 29 | 0 | 0 | 1769 |
| Charlotte, N. C. | 90 | 51 | 115 | 128 | 51 | 115 | 3120 |
| Chattanooga, Tenn. | 157 | 69 | 105 | 218 | 69 | 105 | 3118 |
| Cheyenne, Wyo. | 583 | 625 | 605 | 874 | 937 | 845 | 7466 |
| Chicago, Ill. | 369 | 266 | 350 | 562 | 317 | 350 | 5957 |
| Cincinnati, Ohio | 255 | 170 | 254 | 390 | 194 | 254 | 4684 |
| Cleveland, Ohio | 296 | 307 | 366 | 431 | 360 | 393 | 6155 |
| Columbia, Mo. | 238 | 179 | 260 | 383 | 226 | 260 | 4922 |
| Columbia, S. C. | 38 | 17 | 31 | 59 | 17 | 31 | 2364 |
| Columbus, Ohio | 246 | 214 | 313 | 379 | 240 | 313 | 5398 |
| Concord, N. H. | 467 | 534 | 484 | 657 | 735 | 652 | 7353 |
| Concordia, Kan. | 260 | 288 | 276 | 411 | 347 | 276 | 5315 |
| Dallas, Tex. | 80 | 76 | 0 | 114 | 76 | 0 | 2256 |
| Davenport, Iowa | 316 | 259 | 363 | 499 | 319 | 363 | 6289 |
| Dayton, Ohio | 272 | 214 | 273 | 408 | 248 | 223 | 5264 |
| Denver, Colo. | 423 | 461 | 428 | 576 | 627 | 500 | 5874 |
| Des Moines, Iowa | 318 | 287 | 357 | 511 | 365 | 357 | 6384 |
| Detroit, Mich. | 365 | 329 | 400 | 553 | 390 | 442 | 6490 |
| Devils Lake, N. D. | 530 | 652 | 706 | 934 | 992 | 982 | 9970 |
| Dodge City, Kan. | 268 | 267 | 276 | 367 | 327 | 276 | 5035 |
| Dubuque, Iowa | 386 | 311 | 409 | 599 | 385 | 445 | 6790 |
| Duluth, Minn. | 580 | 588 | 626 | 937 | 849 | 896 | 9443 |
| Eastport, Me. | 487 | 574 | 543 | 740 | 826 | 819 | 8520** |
| Elkins, W. Va. | 328 | 267 | 378 | 468 | 355 | 441 | 5697 |
| El Paso, Tex. | 69 | 72 | 40 | 76 | 72 | 40 | 2428 |
| Ely, Nev. | 605 | 717 | — | 886 | 1134 | — | — |
| Erie, Pa. | 315 | 297 | 378 | 435 | 356 | 414 | 6273 |
| Escanaba, Mich. | 539 | 517 | 591 | 849 | 710 | 834 | 8771* |
| Evansville, Ind. | 246 | 154 | 155 | 372 | 173 | 155 | 4244 |
| Fort Smith, Ark. | 108 | 85 | 62 | 159 | 88 | 62 | 3147 |
| Fort Wayne, Ind. | 373 | 319 | 347 | 557 | 377 | 347 | 5925 |
| Fort Worth, Tex. | 82 | 80 | 0 | 103 | 80 | 0 | 2148 |
| Fresno, Calif. | 74 | 150 | 19 | 74 | 155 | 19 | 2334 |
| Galveston, Tex. | 0 | 5 | 0 | 7 | 5 | 0 | 1016 |
| Grand Junction, Colo. | 308 | 388 | 369 | 347 | 511 | 369 | 5548 |
| Grand Rapids, Mich. | 385 | 338 | 419 | 577 | 408 | 476 | 6535 |
| Green Bay, Wis. | 429 | 410 | 505 | 687 | 526 | 637 | 7825 |
| Greensboro, N. C. | 164 | 115 | 143 | 223 | 119 | 143 | 3529 |
| Greenville, S. C. | 102 | 41 | 146 | 136 | 41 | 146 | 3380 |
| Harrisburg, Pa. | 250 | 236 | 329 | 342 | 266 | 329 | 5357 |
| Hartford, Conn. | 334 | 343 | 344 | 444 | 447 | 392 | 6036 |
| Hatteras, N. C. | 27 | 29 | — | 29 | 29 | — | 2571 |
| Havre, Mont. | 529 | 584 | 620 | 774 | 953 | 890 | 8700** |
| Helena, Mont. | 568 | 697 | 614 | 846 | 1133 | 865 | 7898** |
| Houston, Tex. | 10 | 24 | 0 | 25 | 24 | 0 | 1157 |
| Huron, S. D. | 496 | 462 | 526 | 795 | 619 | 619 | 8004 |
| Indianapolis, Ind. | 266 | 187 | 298 | 399 | 214 | 298 | 5298 |
| Ithaca, N. Y. | 366 | 395 | 443 | 548 | 509 | 539 | 6719 |
| Kansas City, Mo. | 218 | 182 | 219 | 354 | 225 | 219 | 4956 |
| Kewanee, Ill. | 379 | 241 | 334 | 565 | 287 | 412 | 6139 |
| Knoxville, Tenn. | 170 | 82 | 183 | 245 | 82 | 183 | 3670 |
| La Crosse, Wis. | 431 | 389 | 462 | 669 | 500 | 558 | 7322 |
| Lander, Wyo. | 604 | 705 | 654 | 857 | 1076 | 930 | 7947 |

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, and Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table Concluded on Next Page.

# Degree-Days for October, 1942 (Concluded)

HEATING AND VENTILATING'S 15th year of publication of monthly degree-day data

| City | Monthly Degree-Days | | | Cumulative Degree-Days | | | Year[1] |
|---|---|---|---|---|---|---|---|
| | Degree-Days, Oct., 1942 | Degree-Days, Oct., 1941 | Degree-Days, Oct., Normal | Season, 9/1/42-10/31/42 | Season, 9/1/41-10/31/41 | Season, Normal 9/1-10/30 | Normal, 9/1-6/30 |
| Lansing, Mich. | 444 | 387 | 481 | 682 | 491 | 595 | 7048 |
| Lewiston, Me. | 498 | 570 | 501 | 702 | 793 | 666 | 7707 |
| Lincoln, Neb. | 304 | 300 | 316 | 478 | 371 | 316 | 5999 |
| Little Rock, Ark. | 105 | 74 | 47 | 162 | 77 | 47 | 2811 |
| Livingston, Mont. | 563 | 631 | 523 | 871 | 1053 | 750 | 7205 |
| Los Angeles, Calif. | 36 | 71 | 0 | 39 | 75 | 0 | 1504 |
| Louisville, Ky. | 208 | 129 | 186 | 315 | 136 | 186 | 4180 |
| Lynchburg, Va. | 156 | 126 | 220 | 216 | 136 | 220 | 3980 |
| Macon, Ga. | 56 | 53 | 6 | 79 | 53 | 6 | 2201 |
| Madison, Wis. | 414 | 351 | 459 | 645 | 414 | 546 | 7429 |
| Marquette, Mich. | 526 | 543 | 567 | 836 | 739 | 792 | 8693* |
| Memphis, Tenn. | 99 | 77 | 62 | 160 | 79 | 62 | 2950 |
| Meridian, Miss. | 66 | 25 | 22 | 102 | 25 | 22 | 2160 |
| Milwaukee, Wis. | 456 | 388 | 450 | 694 | 493 | 534 | 7245 |
| Minneapolis, Minn. | 457 | 440 | 481 | 739 | 577 | 574 | 7850 |
| Modena, Utah | 458 | 618 | 517 | 620 | 892 | 673 | 6562 |
| Montgomery, Ala. | 31 | 10 | 0 | 50 | 10 | 0 | 1884 |
| Nantucket, Mass. | 284 | 298 | 335 | 375 | 387 | 398 | 5957 |
| Nashville, Tenn. | 140 | 75 | 136 | 213 | 76 | 136 | 3507 |
| New Haven, Conn. | 285 | 272 | 360 | 376 | 344 | 399 | 5895 |
| New Orleans, La. | 17 | 5 | 0 | 22 | 5 | 0 | 1024 |
| New York, N. Y. | 202 | 208 | 276 | 255 | 234 | 276 | 5347 |
| Nome, Alaska‡ | 575 | 603 | 1126 | 575 | 603 | 1870 | 14580** |
| Norfolk, Va. | 65 | 58 | 99 | 89 | 58 | 99 | 3350 |
| Northfield, Vt. | 532 | 602 | 614 | 794 | 874 | 890 | 8719* |
| North Head, Wash. | 310 | 302 | 366 | 548 | 505 | 621 | 5452** |
| North Platte, Neb. | 395 | 403 | 434 | 596 | 535 | 476 | 6366 |
| Oakland, Calif. | 146 | 203 | 183 | 251 | 271 | 273 | 3143** |
| Oklahoma City, Okla. | 142 | 141 | 105 | 208 | 155 | 105 | 3613 |
| Omaha, Neb. | 310 | 313 | 329 | 494 | 390 | 329 | 6131 |
| Oswego, N. Y. | 377 | 404 | 459 | 522 | 525 | 573 | 7088 |
| Parkersburg, W. Va. | 216 | 191 | 285 | 340 | 221 | 285 | 4775 |
| Peoria, Ill. | 318 | 243 | 381 | 507 | 304 | 384 | 6109 |
| Philadelphia, Pa. | 198 | 162 | 242 | 245 | 174 | 242 | 4855 |
| Phoenix, Ariz. | 18 | 34 | 0 | 18 | 34 | 0 | 1405 |
| Pittsburgh, Penn. | 240 | 226 | 313 | 348 | 258 | 313 | 5235 |
| Pocatello, Idaho | 459 | 569 | 499 | 620 | 876 | 655 | 6655 |
| Portland, Me. | 494 | 520 | 477 | 696 | 736 | 639 | 7218 |
| Portland, Ore. | 234 | 271 | 332 | 285 | 384 | 437 | 4469 |
| Providence, R. I. | 292 | 295 | 348 | 376 | 371 | 411 | 6015 |
| Pueblo, Colo. | 391 | 410 | 388 | 513 | 544 | 394 | 5514 |
| Raleigh, N. C. | 108 | 56 | 130 | 148 | 57 | 130 | 3234 |
| Rapid City, S. D. | 482 | 527 | 515 | 766 | 762 | 659 | 7118 |
| Reading, Pa. | 244 | 221 | 344 | 327 | 256 | 344 | 5389 |
| Redding, Calif. | 83 | 115 | 19 | 83 | 126 | 19 | 2451 |
| Reno, Nev. | 417 | 475 | 453 | 559 | 691 | 597 | 5892 |
| Richmond, Va. | 135 | 100 | 161 | 184 | 107 | 161 | 3695 |
| Rochester, N. Y. | 390 | 409 | 431 | 548 | 522 | 503 | 6732 |
| Roseburg, Ore. | 249 | 319 | 350 | 310 | 462 | 461 | 4428 |
| Roswell, N. Mex. | 167 | 164 | 186 | 216 | 196 | 186 | 3484 |
| Sacramento, Calif. | 71 | 131 | 71 | 73 | 139 | 71 | 2653 |
| St. Joseph, Mo. | 247 | 230 | 248 | 405 | 292 | 248 | 5161 |
| St. Louis, Mo. | 197 | 141 | 205 | 313 | 174 | 205 | 4585 |
| Salt Lake City, Utah | 382 | 423 | 388 | 492 | 590 | 406 | 5555 |
| San Antonio, Tex. | 16 | 18 | 0 | 29 | 18 | 0 | 1202 |
| San Diego, Calif. | 26 | 35 | 34 | 26 | 35 | 34 | 1645 |
| Sandusky, Ohio | 308 | 267 | 353 | 441 | 303 | 353 | 6208 |
| San Francisco, Calif. | 134 | 150 | 146 | 289 | 229 | 260 | 3264** |
| Sault Ste. Marie, Mich. | 583 | 627 | 623 | 924 | 891 | 899 | 9285** |
| Savannah, Ga. | 16 | 0 | 0 | 22 | 0 | 0 | 1490 |
| Scranton, Pa. | 338 | 316 | 397 | 466 | 406 | 457 | 6129 |
| Seattle, Wash. | 298 | 322 | 394 | 411 | 507 | 580 | 4934** |
| Sheridan, Wyo. | 512 | 642 | 636 | 755 | 982 | 900 | 8008 |
| Shreveport, La. | 50 | 46 | 0 | 81 | 46 | 0 | 1938 |
| Sioux City, Iowa | 388 | 372 | 415 | 621 | 487 | 448 | 6898 |
| Spokane, Wash. | 457 | 543 | 515 | 577 | 827 | 707 | 6355 |
| Springfield, Ill. | 261 | 185 | 282 | 409 | 231 | 282 | 5373 |
| Springfield, Mo. | 233 | 173 | 217 | 363 | 220 | 217 | 4428 |
| Syracuse, N. Y. | 399 | 395 | 425 | 566 | 534 | 521 | 6893 |
| Tacoma, Wash. | 327 | 364 | 400 | 470 | 576 | 607 | 5181** |
| Terre Haute, Ind. | 258 | 178 | 233 | 385 | 209 | 233 | 4872 |
| Toledo, Ohio | 348 | 288 | 369 | 512 | 336 | 378 | 6077 |
| Topeka, Kan. | 205 | 202 | 236 | 339 | 255 | 236 | 4969 |
| Trenton, N. J. | 242 | 215 | 242 | 308 | 249 | 242 | 4933 |
| Utica, N. Y. | 421 | 467 | 430 | 597 | 615 | 612 | 6796 |
| Valentine, Neb. | 479 | 475 | 490 | 743 | 648 | 583 | 7039** |
| Walla Walla, Wash. | 246 | 367 | 332 | 275 | 493 | 362 | 4808 |
| Washington, D. C. | 153 | 144 | 251 | 212 | 153 | 251 | 4626 |
| Wichita, Kan. | 209 | 213 | 192 | 323 | 259 | 192 | 4673 |
| Williston, N. D. | 580 | 617 | 660 | 913 | 959 | 930 | 9323 |
| Winnemucca, Nev. | 436 | 535 | 507 | 571 | 825 | 699 | 6427** |
| Yakima, Wash. | 339 | 428 | 437 | 371 | 604 | 557 | 5599 |

‡Nome data are for September.
*Includes August.
**Includes July and August.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

# HEAT REFLECTING PAINT

## HAS CAMOUFLAGE PROPERTIES

The accompanying photographs illustrate how low visibility heat-reflecting paint has been applied in two cases. The paint used in these cases has the property of reflecting infra-red rays, so that it not only turns back the heat but makes it difficult for an enemy to penetrate the visual camouflage with infra-red photography, now widely used in aerial reconnaissance. Named Infray, the heat-reflecting paint was developed by The Arco Company, Cleveland.

**The view to the left shows in the distance a scientific laboratory housing painted with aluminum. Note the bright highlight glare, prominent in contrast to the foliage. In the center is shown the same housing after painting with Infray olive drab paint. The illustration at the right is the same as the center view but taken on infra-red film. The housing appears white, as does the foliage. Ordinary dark paint would have shown up black on the infra-red film. Fuel storage tanks and air conditioned buildings, where heat-reflecting surfaces are highly desirable, are some typical applications where the new paint will be found useful.**

**New buses in Washington are illustrated above (left) with roofs finished with two kinds of paint. The forward (left) bus has an aluminum-painted roof to reflect heat. The roof of the rear bus is finished with Infray paint to reflect the heat. The latter provides camouflage, blending in with the surroundings in both the normal (left) and infra-red (right) photographs. Note the dark water surface on the infra-red view, indicating heat absorption.**

# REVIEWS of TECHNICAL publications

## HEAT TRANSFER IN WOOD

**"The Effect of Wood Structure Upon Heat Conductivity," by F. F. Wangaard. Paper presented at the Fall Meeting of the American Society of Mechanical Engineers, October 12-14, 1942.**

Previous studies on heat conductivities in wood have shown certain relationships existing between specific gravity and moisture content on the one hand and the conductivity transverse or perpendicular to the grain in the wood, on the other hand. At the same time other factors were known to influence conductivity and that conductivity parallel to the grain was from two to three times as great as in the transverse direction.

In this eight-page study the author, who is assistant professor of Forestry at the University of Washington, discusses the effect of fibrillar orientation upon conductivity and shows that the differentiation between longitudinal and transverse conductivities are due, chiefly, to the anisotropic character of the fibrils. Anticipated conductivities are also shown to be closely related to fibrillar orientation.

All of the experimental work upon which the conclusions were based were made upon Douglas fir.

## GAS VALVE STANDARD

**"Listing Requirements for Gas Valves." Published by the American Standards Association, 29 W. 39th Street, New York, N. Y. Price, 50 cents.**

The requirements listed in this new standard, which is to go into effect January 1, 1943, supplement the American Standard Gas Safety Code K-2, 1927 and its provisions agree in principle with the rules of that code.

Such construction requirements as the following are included: dimensions; compensation for wear; valve stems and handles; stops; latching type valves; strength; materials; assembly and marking; and such performance requirements as leakage; capacity; gas range burner valves with adjustable orifices, and continued operation.

Paper covered, 6¾ x 10 in., 20 pages.

## COAL UTILIZATION

**"Papers Presented at the Sixth Short Course in Coal Utilization." Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price, 50 cents.**

Bulletin No. 41 of the University of Illinois Engineering Experiment Station has the complete papers presented at the 1941 short course held at the University. The purpose of this course was to present an educational program of technical and practical information pertaining to coal and its efficient utilization for the benefit of those engaged in mining, preparing, marketing and using coal, as well as for those manufacturing and distributing machinery for the preparation and utilization of coal.

Included among the many papers presented were the following: New Developments in Air Cleaning of Coal, W. C. McCulloch; Ash Control in Coal Washing Plants, P. W. F. J. Moran; Principles of Smoke Formation and Elimination, B. A. Landry; New Developments in Stoker Design, F. Hoke; Coal Analyses and Their Relation to Combustion Characteristics, J. L. G. Weysser; and, New Developments in Steam and Water Heating Systems, R. E. Ferry.

One hundred and twelve pages, 6 x 9 in., paper covered.

## STOKERS

**"Stoker Heating Guide," by K. C. Richmond. Published by Coal-Heat Magazine, 20 W. Jackson Blvd., Chicago, Ill. Price, 10 cents.**

This 4 by 9 in. 24-page pamphlet tells in simple, effective language a very complete story about stoker operation. Many practical rules are included, covering the checking, adjustment and operation of stoker installations, the purpose being to keep fuel consumption as low as possible with a minimum of servicing and a maximum of comfort. Some of the subjects covered are inspection, cleaning, air control, stack draft, stoker fuel beds, choice of coal, insulation, storm windows, weather stripping and controls.

Pamphlet available in quantities at $6.00 a hundred.

## GAS BURNING EQUIPMENT STANDARD

**"Requirements for Installation of Gas-Burning Equipment in Power Boilers." Published by the American Standards Association, 29 W. 39th Street, New York, N. Y. Price, 50 cents.**

This new standard, effective January 1, 1943, was sponsored by the American Gas Association and supplements the American Standard Gas Safety Code K-2, 1927.

The requirements covered include: installation of burners and controls; gas piping and meters; inspections and tests; as well as boiler room ventilation, accessibility for cleaning and inspection, and flues and flue connections.

Paper covered, 6¾ x 10 in., 17 pages.

## STABLE VENTILATION

**"Dairy-Stable Ventilation," by F. L. Fairbanks and A. M. Goodman. Bulletin 151 published by the New York State College of Agriculture, Cornell University, Ithaca, N. Y. Price 5 cents.**

This 32-page, 6 x 9 in. pamphlet outlines the theory as well as applied operating principles of ventilation of cattle barns. The various steps in planning and constructing a ventilation system for a dairy stable are outlined in detail. The phases covered include air space as related to the number of cattle; the determination, location and construction of the exhaust and intake flues; insulation and its effect on comfort and air movement; location and types of doors and windows; and general operating information. Electric or forced-air fan ventilation is also discussed at the end of the pamphlet.

## SPECIFIC HEATS

**"The Specific Heats of Certain Gases over wide Ranges of Pressures and Temperatures," by Frank O. Ellenwood, Nicholas Kulik and Norman R. Gay. Published by The College of Engineering, Cornell University, Ithaca, N. Y. Price 50 cents.**

Bulletin No. 30, 32 pages, paper-covered, presents the results of a study of variation of the specific heats with changes in temperature and pressure for eight gases: air, CO, $CO_2$, $CH_4$, $C_2H_4$, $H_2$, $N_2$, and $O_2$. General equations cover the effect of pressure on specific heat and this effect is also shown graphically. The range of temperatures is from 0 to 4000F and pressures from 0 to 10,000 lb per sq in. A bibliography of the subject is included.

## SAFETY STANDARDS

**"Handbook of Industrial Safety Standards." Published by National Conservation Bureau, 60 John Street, New York, N. Y. Paper cover, 55 cents per copy; green leatherette cover, 75 cents per copy.**

This useful little handbook has been revised to include the latest safety developments and protective methods against sabotage and air raids against American war plants. Most of the material of the book is based upon safety codes of the American Standards Association, American Society of Mechanical Engineers, fire underwriters, governmental agencies, and the recommendations of engineering and other organizations recognized as national authorities on accident prevention.

The main portion of the book is composed of the following chapters: Supervision, Inspection, and Employee Education; First Aid and Hospital; Resuscitation; Personal Protection; Housekeeping and Storage of Materials; Sanitation; Illumination; Building Exits; Tripping and Falling, Protection Against; Elevators; Crane, Traveling; Handling and Transportation of Material; Steam Boilers; Unfired Pressure Vessels; Engines and Turbines; Identification of Piping; Electrical Equipment; Mechanical Power Transmission Equipment; Moving Parts of Machines; Woodworking Machines, Guards for; Metal Working Machines, Guards for; Paper and Printing Machines, Guards for; Leather Working Machines, Guards for; Textile and Laundry Machines, Guards for; Machines in the Food Industry, Guards for; Rubber Working and Similar Machines, Guards for; Hand Tools; Exhaust; Explosive Vapors and Gases; Spray Coating; Tank Operations; Acids and Caustic Liquids.

Booklet is 5½ by 7½ in., contains 222 pages with 67 illustrations and is cross-indexed in detail.

## COAL COMPOSITION

**"Typical Analyses of Coals of the United States," by A. C. Fieldner, W. E. Rice, and H. E. Moran. For sale by the Superintendent of Documents, Washington, D. C. Price, 10 cents.**

This Bureau of Mines publication, Bulletin 446, presents a summary in tabular form of the composition of commercial coal resources of the country. The summarized data are based on a great number of analyses gathered by the Bureau on virtually every coal field of commercial importance in the United States.

Specimen analyses are given exemplifying the analysis of coal mined in each coal-producing county, or, where it was feasible, coal from each bed in each county; also, ranges of analyses, within which the composition of most of the coal represented will fall, are given where there were enough analyses to permit satisfactory determination of the ranges. In addition, the degree of metamorphism from lignite toward anthracite of much of the coal is indicated by the classification by rank.

## HOUSING

**"A Glossary of Housing Terms." Report BMS91. Superintendent of Documents, Washington, D. C. Price, 15 cents.**

Compiled by the Subcommittee on Definitions, Central Housing Committee on Research, Design, and Construction, this second edition supplements the original edition which appeared in 1937. The compilers found that in the intervening five-year period many changes had occurred in the meanings of terms in general use in the housing field, and the purpose of the new edition is to bring together for convenient use the generally accepted definitions of a limited number of these terms currently used in housing literature. The original edition listed approximately 470 such terms, while the new edition has been revised and expanded to include about 800.

Paper-covered, 8 by 10½ in., 32 pages.

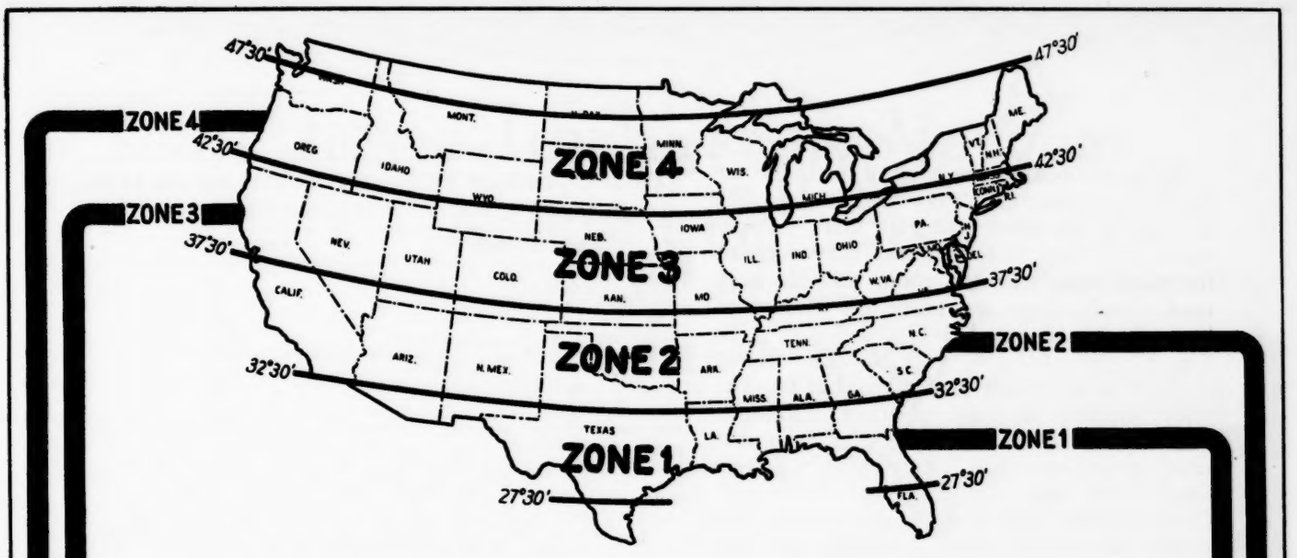
## FOOD DEHYDRATION

**"What the Air Conditioning Engineer Should Know About Food Dehydration." Published by The Industrial Press, 148 Lafayette Street, New York, N. Y., from HEATING AND VENTILATING, December, 1942. Price, 25 cents.**

This 16-page standard size pamphlet, printed in russet colored ink on India tint coated stock, lists the principles, types of dryers and methods of calculation of air, moisture, heat quantities and air velocities in the dehydration of foods. A discussion of packaging is included. Pamphlet has 20 illustrations and five tables, and constitutes HEATING AND VENTILATING's Reference Section No. 8.

# YEAR-ROUND SUN ANGLES FOR THE U. S.

## TABLE 1. AZIMUTH AND ALTITUDE ANGLES




## SOLAR AZIMUTH AND ALTITUDE ANGLES

| SUN TIME | JAN. 21 | | FEB. 20 | | MAR. 21 | | APR. 20 | | MAY 21 | | JUNE 21 | | JULY 23 | | AUG. 24 | | SEPT. 21 | | OCT. 23 | | NOV. 21 | | DEC. 22 | | SUN TIME |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | AZI. | ALT. | |
| 6 AM | | | | | 90 | 0 | 79 | 6 | 72 | 14 | 73 | 12 | 72 | 14 | 79 | 6 | 90 | 0 | | | | | | | 6 AM |
| 7 | 113 | 0 | 107 | 8 | 97 | 10 | 87 | 20 | 78 | 23 | 76 | 23 | 78 | 23 | 87 | 20 | 97 | 10 | 107 | 8 | 113 | 0 | | | 7 |
| 8 | 123 | 13 | 117 | 18 | 105 | 25 | 96 | 32 | 85 | 35 | 82 | 37 | 85 | 35 | 96 | 32 | 105 | 25 | 117 | 18 | 123 | 13 | 125 | 11 | 8 |
| 9 | 133 | 24 | 127 | 29 | 116 | 37 | 105 | 44 | 93 | 48 | 88 | 49 | 93 | 48 | 105 | 44 | 116 | 37 | 127 | 29 | 133 | 24 | 136 | 21 | 9 |
| 10 | 147 | 32 | 141 | 39 | 130 | 49 | 118 | 56 | 104 | 61 | 96 | 62 | 104 | 61 | 118 | 56 | 130 | 49 | 141 | 39 | 147 | 32 | 148 | 29 | 10 |
| 11 | 162 | 38 | 158 | 46 | 152 | 56 | 140 | 66 | 123 | 73 | 113 | 75 | 123 | 73 | 140 | 66 | 152 | 56 | 158 | 46 | 162 | 38 | 163 | 35 | 11 |
| NOON | 180 | 40 | 180 | 49 | 180 | 60 | 180 | 71 | 180 | 80 | 180 | 83 | 180 | 80 | 180 | 71 | 180 | 60 | 180 | 49 | 180 | 40 | 180 | 37 | NOON |
| 1 PM | 162 | 38 | 158 | 46 | 152 | 56 | 140 | 66 | 123 | 73 | 113 | 75 | 123 | 73 | 140 | 66 | 152 | 56 | 158 | 46 | 162 | 38 | 163 | 35 | 1 PM |
| 2 | 147 | 32 | 141 | 39 | 130 | 49 | 118 | 56 | 104 | 61 | 96 | 62 | 104 | 61 | 118 | 56 | 130 | 49 | 141 | 39 | 147 | 32 | 148 | 29 | 2 |
| 3 | 133 | 24 | 127 | 29 | 116 | 37 | 105 | 44 | 93 | 48 | 88 | 49 | 93 | 48 | 105 | 44 | 116 | 37 | 127 | 29 | 133 | 24 | 136 | 21 | 3 |
| 4 | 123 | 13 | 117 | 18 | 105 | 25 | 96 | 32 | 85 | 35 | 82 | 37 | 85 | 35 | 96 | 32 | 105 | 25 | 117 | 18 | 123 | 13 | 125 | 11 | 4 |
| 5 | 113 | 0 | 107 | 8 | 97 | 10 | 87 | 20 | 78 | 23 | 76 | 23 | 78 | 23 | 87 | 20 | 97 | 10 | 107 | 8 | 113 | 0 | | | 5 |
| 6 | | | | | 90 | 0 | 79 | 6 | 72 | 14 | 73 | 12 | 72 | 14 | 79 | 6 | 90 | 0 | | | | | | | 6 |

| 6 AM | | | | | 90 | 0 | 80 | 7 | 73 | 15 | 75 | 11 | 73 | 15 | 80 | 7 | 90 | 0 | | | | | | | 6 AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | | | 108 | 8 | 98 | 10 | 90 | 20 | 81 | 24 | 78 | 24 | 81 | 24 | 90 | 20 | 98 | 10 | 108 | 8 | | | | | 7 |
| 8 | 124 | 11 | 118 | 17 | 108 | 24 | 98 | 31 | 90 | 35 | 85 | 37 | 90 | 35 | 98 | 31 | 108 | 24 | 118 | 17 | 124 | 11 | 126 | 10 | 8 |
| 9 | 135 | 21 | 128 | 27 | 120 | 35 | 108 | 42 | 99 | 48 | 94 | 48 | 99 | 48 | 108 | 42 | 120 | 35 | 128 | 27 | 135 | 21 | 137 | 17 | 9 |
| 10 | 148 | 28 | 143 | 36 | 134 | 45 | 122 | 54 | 112 | 60 | 106 | 61 | 112 | 60 | 122 | 54 | 134 | 45 | 143 | 36 | 148 | 28 | 149 | 24 | 10 |
| 11 | 163 | 32 | 160 | 41 | 155 | 52 | 146 | 62 | 133 | 69 | 127 | 73 | 133 | 69 | 146 | 62 | 155 | 52 | 160 | 41 | 163 | 32 | 164 | 29 | 11 |
| NOON | 180 | 35 | 180 | 44 | 180 | 56 | 180 | 66 | 180 | 75 | 180 | 77 | 180 | 75 | 180 | 66 | 180 | 56 | 180 | 44 | 180 | 35 | 180 | 31 | NOON |
| 1 PM | 163 | 32 | 160 | 41 | 155 | 52 | 146 | 62 | 133 | 69 | 127 | 73 | 133 | 69 | 146 | 62 | 155 | 52 | 160 | 41 | 163 | 32 | 164 | 29 | 1 PM |
| 2 | 148 | 28 | 143 | 36 | 134 | 45 | 122 | 54 | 112 | 60 | 106 | 61 | 112 | 60 | 122 | 54 | 134 | 45 | 143 | 36 | 148 | 28 | 149 | 24 | 2 |
| 3 | 135 | 21 | 128 | 27 | 120 | 35 | 108 | 42 | 99 | 48 | 94 | 48 | 99 | 48 | 108 | 42 | 120 | 35 | 128 | 27 | 135 | 21 | 137 | 17 | 3 |
| 4 | 124 | 11 | 118 | 17 | 108 | 24 | 98 | 31 | 90 | 35 | 85 | 37 | 90 | 35 | 98 | 31 | 108 | 24 | 118 | 17 | 124 | 11 | 126 | 10 | 4 |
| 5 | | | 108 | 8 | 98 | 10 | 90 | 20 | 81 | 24 | 78 | 24 | 81 | 24 | 90 | 20 | 98 | 10 | 108 | 8 | | | | | 5 |
| 6 | | | | | 90 | 0 | 80 | 7 | 73 | 15 | 75 | 11 | 73 | 15 | 80 | 7 | 90 | 0 | | | | | | | 6 |

| 6 AM | | | | | 90 | 0 | 81 | 8 | 74 | 16 | 75 | 13 | 74 | 16 | 81 | 8 | 90 | 0 | | | | | | | 6 AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | | | 108 | 8 | 98 | 9 | 91 | 19 | 84 | 25 | 80 | 25 | 84 | 25 | 91 | 19 | 98 | 9 | 108 | 8 | | | | | 7 |
| 8 | 124 | 9 | 118 | 15 | 110 | 22 | 101 | 30 | 93 | 36 | 88 | 37 | 93 | 36 | 101 | 30 | 110 | 22 | 118 | 15 | 124 | 9 | 126 | 9 | 8 |
| 9 | 136 | 16 | 131 | 24 | 123 | 32 | 112 | 41 | 104 | 47 | 100 | 48 | 104 | 47 | 112 | 41 | 123 | 32 | 131 | 24 | 136 | 16 | 138 | 14 | 9 |
| 10 | 149 | 24 | 145 | 32 | 137 | 41 | 128 | 51 | 120 | 58 | 114 | 60 | 120 | 58 | 128 | 51 | 137 | 41 | 145 | 32 | 149 | 24 | 151 | 20 | 10 |
| 11 | 163 | 28 | 162 | 37 | 157 | 47 | 152 | 59 | 143 | 66 | 138 | 69 | 143 | 66 | 152 | 59 | 157 | 47 | 162 | 37 | 163 | 28 | 165 | 24 | 11 |
| NOON | 180 | 29 | 180 | 39 | 180 | 50 | 180 | 61 | 180 | 70 | 180 | 73 | 180 | 70 | 180 | 61 | 180 | 50 | 180 | 39 | 180 | 29 | 180 | 25 | NOON |
| 1 PM | 163 | 28 | 162 | 37 | 157 | 47 | 152 | 59 | 143 | 66 | 138 | 69 | 143 | 66 | 152 | 59 | 157 | 47 | 162 | 37 | 163 | 28 | 165 | 24 | 1 PM |
| 2 | 149 | 24 | 145 | 32 | 137 | 41 | 128 | 51 | 120 | 58 | 114 | 60 | 120 | 58 | 128 | 51 | 137 | 41 | 145 | 32 | 149 | 24 | 151 | 20 | 2 |
| 3 | 136 | 16 | 131 | 24 | 123 | 32 | 112 | 41 | 104 | 47 | 100 | 48 | 104 | 47 | 112 | 41 | 123 | 32 | 131 | 24 | 136 | 16 | 138 | 14 | 3 |
| 4 | 124 | 9 | 118 | 15 | 110 | 22 | 101 | 30 | 93 | 36 | 88 | 37 | 93 | 36 | 101 | 30 | 110 | 22 | 118 | 15 | 124 | 9 | 126 | 9 | 4 |
| 5 | | | 108 | 8 | 98 | 9 | 91 | 19 | 84 | 25 | 80 | 25 | 84 | 25 | 91 | 19 | 98 | 9 | 108 | 8 | | | | | 5 |
| 6 | | | | | 90 | 0 | 81 | 8 | 74 | 16 | 75 | 13 | 74 | 16 | 81 | 8 | 90 | 0 | | | | | | | 6 |

| 6 AM | | | | | 90 | 0 | 82 | 8 | 75 | 16 | 77 | 15 | 75 | 16 | 82 | 8 | 90 | 0 | | | | | | | 6 AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | | | | | 101 | 8 | 93 | 18 | 87 | 26 | 83 | 26 | 87 | 26 | 93 | 18 | 101 | 8 | | | | | | | 7 |
| 8 | 125 | 8 | 119 | 13 | 111 | 20 | 103 | 30 | 96 | 35 | 92 | 37 | 96 | 35 | 103 | 30 | 111 | 20 | 119 | 13 | 125 | 8 | 127 | 9 | 8 |
| 9 | 137 | 13 | 132 | 22 | 124 | 29 | 117 | 39 | 109 | 46 | 105 | 47 | 109 | 46 | 117 | 39 | 124 | 29 | 132 | 22 | 137 | 13 | 139 | 8 | 9 |
| 10 | 150 | 17 | 146 | 27 | 140 | 38 | 133 | 47 | 125 | 55 | 121 | 56 | 125 | 55 | 133 | 47 | 140 | 38 | 146 | 27 | 150 | 17 | 152 | 13 | 10 |
| 11 | 164 | 22 | 163 | 32 | 160 | 44 | 154 | 54 | 148 | 63 | 146 | 64 | 148 | 63 | 154 | 54 | 160 | 44 | 163 | 32 | 164 | 22 | 165 | 18 | 11 |
| NOON | 180 | 24 | 180 | 34 | 180 | 45 | 180 | 56 | 180 | 65 | 180 | 69 | 180 | 65 | 180 | 56 | 180 | 45 | 180 | 34 | 180 | 24 | 180 | 22 | NOON |
| 1 PM | 164 | 22 | 163 | 32 | 160 | 44 | 154 | 54 | 148 | 63 | 146 | 64 | 148 | 63 | 154 | 54 | 160 | 44 | 163 | 32 | 164 | 22 | 165 | 18 | 1 PM |
| 2 | 150 | 17 | 146 | 27 | 140 | 38 | 133 | 47 | 125 | 55 | 121 | 56 | 125 | 55 | 133 | 47 | 140 | 38 | 146 | 27 | 150 | 17 | 152 | 13 | 2 |
| 3 | 137 | 13 | 132 | 22 | 124 | 29 | 117 | 39 | 109 | 46 | 105 | 47 | 109 | 46 | 117 | 39 | 124 | 29 | 132 | 22 | 137 | 13 | 139 | 8 | 3 |
| 4 | 125 | 8 | 119 | 13 | 111 | 20 | 103 | 30 | 96 | 35 | 92 | 37 | 96 | 35 | 103 | 30 | 111 | 20 | 119 | 13 | 125 | 8 | 127 | 9 | 4 |
| 5 | | | | | 101 | 8 | 93 | 18 | 87 | 26 | 83 | 26 | 87 | 26 | 93 | 18 | 101 | 8 | | | | | | | 5 |
| 6 | | | | | 90 | 0 | 82 | 8 | 75 | 16 | 77 | 15 | 75 | 16 | 82 | 8 | 90 | 0 | | | | | | | 6 |

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**H. & V.'s REFERENCE DATA — 235**

# YEAR-ROUND SUN ANGLES FOR THE U. S.

When estimating the cooling load, the air conditioning engineer may find it desirable to analyze the solar heat gain load, since in many buildings this sun heat may account for more than half the room sensible heat load. Such data are given on Reference Data .83-84, 85-86, 173-174, 175-176, 177-178, 179-180, 197-198, and 225-226. However, in many cases it is advisable to consider shading due to adjacent buildings, window recesses, or inner courts of multi-wing structures when determining the individual room load and simultaneous maximum load. Consequently, this sheet is designed to show the angles themselves (both azimuth and altitude), in simple form covering twelve months so that the effect and magnitude of shading can be analyzed. The incident angle on any exposure can also be determined if desired.

The use of the table itself is simple; the accompanying drawings illustrate the definitions of azimuth, altitude, and incident angles.

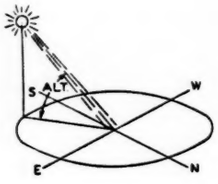
**TABLE 2.—ANGLE BETWEEN NORTH-SOUTH LINE AND WALL PERPENDICULAR**

| Wall Facing | Angle Y, Deg. |
|---|---|
| North | 0 |
| Northeast | 45 |
| East | 90 |
| Southeast | 135 |
| South | 180 |
| Southwest | 135 |
| West | 90 |
| Northwest | 45 |

## DEFINITIONS

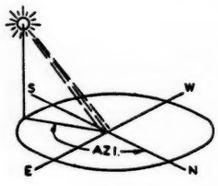
**ALTITUDE ANGLE**

**The angle in a vertical plane between the sun's rays and the earth's surface.**



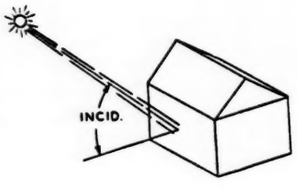

**AZIMUTH ANGLE**

**The angle between the intersection of the vertical plane and the north-south line.**




**INCIDENT ANGLE**

**The angle between the sun's rays and a perpendicular to the surface on which the rays are impinging.**




The incident angle can be easily calculated by using Table 1 in relation to Table 2: (1) From Table 2, and knowing the direction in which the given wall faces, determine the angle Y between the wall perpendicular and the North-South line; (2) Determine the azimuth angle for the hour and month in question from Table 1; (3) Subtract (1) from (2) or vice versa to find the angular difference X; (4) Find the incident angle by solving the formula

$$\text{Cos Incident Angle} = \text{Cos Altitude Angle} \times \text{Cos X}.$$

For roofs, the incident angle is 90° minus the altitude angle.

*Example:* What is the incident angle in latitude 35°N (a) on a Southeast wall on August 24 at 11 a.m. and (b) on the roof at the same time?

Solution: (1) From Table 2 for a Southeast wall, Y = 135°; (2) From Table 1 the azimuth for August 24, 11 a.m., 35°N, is 146°; (3) Subtracting (1) from (2), 146° — 135° = 11°; (4) From Table 1, the altitude angle is 62°; (5) The cosine of 11° is 0.98 and of 62° is 0.47 so that

$$\text{Cos Incident Angle} = \text{Cos Altitude Angle} \times \text{Cos X} = .47 \times .98 = .46$$

and the Incident Angle for the wall is thus 62° 25′.

For the roof, the incident angle is 90° — 62° = 28° for which the cosine is .88.

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**H. & V.'s REFERENCE DATA — 236**

# Correcting a Troublesome Vacuum Return Line

By W. F. FISCHER

**Trouble in a vacuum heating system sometimes is attributed to faulty action of the boiler, vacuum pump, or traps, while the real trouble lies hidden in some obscure feature of the piping, wherein design or installation has been at fault. The author analyzes such a case, and shows how corrections were arrived at and made.**

MUCH of the trouble experienced with vacuum heating systems can be traced to faulty design and poor arrangement of the return piping located between the radiators and the vacuum pump. In a well-balanced system, the point of lowest steam pressure, usually the farthest radiator from the boiler, should be favored with the highest vacuum in the return line at that point. Conversely, the point of highest steam pressure, usually the radiator closest to the boiler, should be the point of lowest vacuum in the return line.

Perfect balance between the supply and return at all radiators and drip points can only be obtained when the pressure-differential is the same at all such points. This result can be approximated, in some cases, by running the supply and return mains in opposite directions, or by dividing the return main into sections—so arranged as to provide as far as possible the same, or nearly the same, difference in pressure between the steam to each radiator and the return from each radiator in the system.

The vacuum maintained in the return main by the vacuum pump should not be greater than that required for the proper circulation and drainage in all parts of the system, and the return piping should be so arranged and graded that the condensate will flow by gravity to the pump inlet.

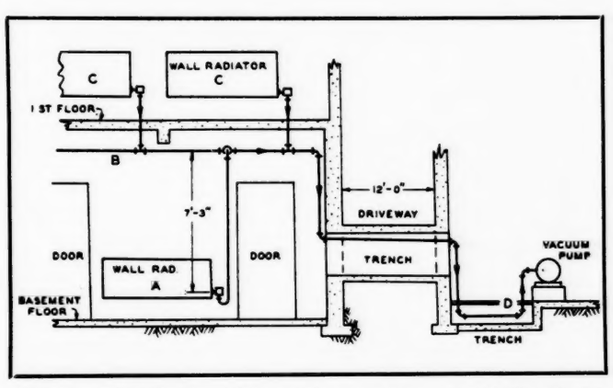



*Fig. 1. Elevation of the return system as originally installed. Note the 7 ft 3 in. lift required from the basement radiators as against the gravity flow from the upper ones*

### Vapor in the Return Line

When hot water is discharged from the radiators through traps to the return line, part of the water is flashed to steam or vapor due to the drop in pressure; and the greater the pressure-differential maintained the greater will be the amount of vapor to be handled by the pump. If this vapor is not condensed before it reaches the pump, the pump will not operate satisfactorily, but may race and pound. The amount of steam or vapor in cubic feet that is released from each pound of condensate, when discharged from a radiator or pipe coil into the return line where the pressure is maintained at a lower pressure, can be calculated. Table 1 shows the amount of vapor thus released for various vacuums. The steam temperature at the trap inlet is assumed to be 212F.

### Result of Incorrect Design

Fig. 1 shows the elevation of a vacuum return system which, owing to the poorly arranged system of return piping, started giving trouble the first day it was put in operation. The condensate from basement radiators A had to be lifted 7 ft 3 in. to a common overhead return main B, which also received, by gravity, the condensate from the upper floor radiators C. The basement radiators were badly flooded most of the time, and the Vacuum pump, although equipped with a governor, raced and pounded so badly at times that it had to be shut down.

Setting the pump governor for a higher vacuum, in order to drain the basement radiators, only made matters worse; the vapor, air and other gases released from the condensate from the upper floor

TABLE 1.

| Vacuum in Return Line, Inches of Mercury | Absolute Pressure in Return Line, Pounds per Sq. In. | Percentage of Condensate Re-evaporated in Return Line | Cubic Feet of Vapor from One Pound of Condensate | Final Temperature of Condensate and Vapor in Return Line, F |
|---|---|---|---|---|
| 0 | 14.70 | 0 | 0 | 212 |
| 1 | 14.20 | 0.17 | 0.04 | 210.2 |
| 2 | 13.72 | 0.36 | 0.10 | 208.4 |
| 3 | 13.23 | 0.54 | 0.16 | 206.7 |
| 4 | 12.75 | 0.73 | 0.22 | 204.8 |
| 5 | 12.26 | 0.92 | 0.30 | 202.9 |
| 6 | 11.76 | 1.13 | 0.37 | 200.8 |
| 7 | 11.28 | 1.35 | 0.46 | 198.8 |
| 8 | 10.79 | 1.57 | 0.56 | 196.7 |
| 9 | 10.28 | 1.79 | 0.67 | 194.4 |
| 10 | 9.80 | 2.03 | 0.80 | 192.2 |
| 11 | 9.32 | 2.27 | 0.94 | 188.8 |
| 12 | 8.83 | 2.52 | 1.09 | 187.2 |
| 13 | 8.34 | 2.79 | 1.27 | 184.6 |
| 14 | 7.84 | 3.07 | 1.49 | 181.9 |
| 15 | 7.35 | 3.36 | 1.71 | 179.1 |

radiators increased in volume as the vacuum increased, and as soon as the pump had removed whatever condensate had collected in the return line under the boiler room floor at D, the vapor, air and gases entering the pump broke the vacuum and the pump immediately started to race and pound worse than before.

### How Corrections Were Made

Either of two methods was applicable for the correction of this system. Fig. 2 shows the one chosen. Fig. 3 illustrates the alternate method, described later in this article.

Referring to Fig. 2, a separate overhead return main E was installed to care for the four basement radiators (only one of which is shown). The drop leg from the old main B was cut, and a water-seal or loop F installed to collect the condensate from the upper floor radiators before it entered the common connecting main leading through the pipe trench. Lift-fittings were installed at the vacuum pump, as shown at G and H. After making these changes the system was found to operate quite satisfactorily in all respects, and it was possible to reduce the vacuum considerably.

These changes were prompted by the following line of reasoning:

Water at 212F weighs approximately 59.76 lb per cu ft; hence a column of water at this temperature and $\frac{144}{59.76}$, or 2.41 ft, in height will just balance a pressure of one pound per square inch at its base. In order to drain the basement radiators into the overhed return line, which was 7 ft 3 in. above the inlet of the radiator traps, a pressure differential of at least $\frac{7.25}{2.41}$, or 3 lb per sq in., was required.

Assuming the average pressure in the basement radiators to be, say, 0.5 lb per sq in. gage, the pressure in the return line, at a corresponding point, would have to be not greater than (14.7 + 0.5) — 3, or 12.2 lb absolute. From Table1, this corresponds to a vacuum of approximately 5 in. of mercury, a vacuum easily maintained by a tight pump. But when we consider the volumetric capacity of the return line, and the fact that 0.3 cu ft of vapor (Table 1) is released in the return line from every pound of condensate leaving the upper floor radiators, we can readily understand why the basement radiators remained water-logged while the upper floor radiators were discharging condensate freely into the return main. The basement radiators drained freely only when all upper floor radiators were shut off completely.

With the new arrangement of piping the condensate is lifted 7 ft 10 in. in the overhead main E, the connection from each basement radiator being taken into the top of the main as shown, to prevent the water from draining back again to the radiators. When the radiator traps open, the mixture of condensate, vapor, air and other gases descends in slugs at fairly high velocity; these slugs of condensate

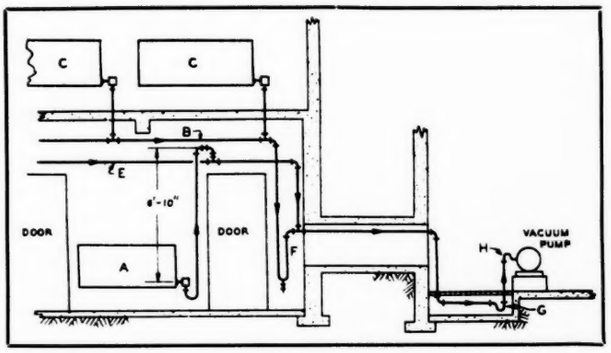



*Fig. 2. The same system after piping corrections were made. Note the addition of auxiliary line E and suction loop.*

being much lighter than a solid column of water, require a somewhat lower pressure differential than assumed above. Due to the resistance offered by the water-seal F, the pressure differential between the basement radiators A and the vacuum pump is always somewhat greater than it is between the upper floor radiators C and the pump. The condensate from the upper floor radiators is cooled in the loop F (the piping being left uncovered for this purpose) and re-condenses some of the vapor passing over from the basement radiators into the branch through the underground trench.

The riser connecting the two lift fittings G and H at the vacuum pump, is usually made from one to two sizes smaller than the horizontal return main, the purpose of this being to increase the velocity in the riser and prevent the ascending slugs of condensate, vapor, air and other gases from being broken up in the riser before reaching the top, where the condensate is prevented from returning again, by the inverted fitting H.

Manufacturers of lift fittings recommend that lifts over five feet in height be made in two or more steps. This is always advisable, since by doing so the work on the vacuum pump is reduced considerably, inasmuch as the two or more steps may not be lifting condensate at the same time.

### Positive Vacuum Control

Another and a more positive method of correcting the trouble could have been used. This utilizes

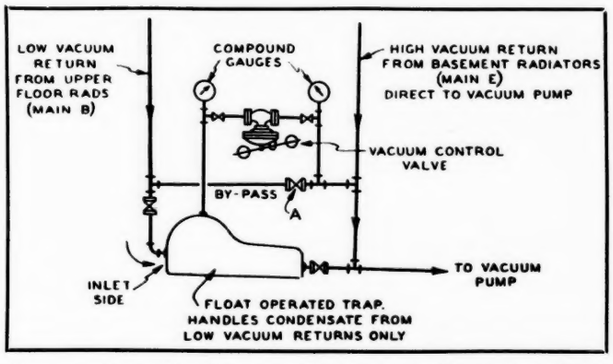

LOW VACUUM RETURN FROM UPPER FLOOR RADS (MAIN B)
COMPOUND GAUGES
HIGH VACUUM RETURN FROM BASEMENT RADIATORS (MAIN E) DIRECT TO VACUUM PUMP
VACUUM CONTROL VALVE
BY-PASS
A
TO VACUUM PUMP
INLET SIDE
FLOAT OPERATED TRAP. HANDLES CONDENSATE FROM LOW VACUUM RETURNS ONLY

*Fig. 3. Schematic diagram showing an alternate method of correction to that shown in Fig. 2. The combination of float operated trap and vacuum control valve gives positive operation, capable of close adjustment.*

standard vacuum specialties, arranged as shown in Fig. 3. These consist of a float-operated condensation trap, a vacuum control pilot valve, and a pair of compound pressure-vacuum gages, connected as shown. Five valves are used in the pipe connections but when the system is in operation all valves are open except the one in the by-pass line marked A.

The returns from the high-vacuum line (in this case, from the basement radiators) do not go through the condensation trap, but pass directly to the vacuum pump. The returns from the low-vacuum line (in this case from the upper floor radiators) pass to the trap, which then discharges it to the high-vacuum line as shown. The trap is vented through the vacuum-control valve, into the high-vacuum line.

With this arrangement, the vacuum pump governor can be set for the exact degree of vacuum required in the high-vacuum line E, after which the vacuum-control valve is set for the degree of vacuum required in the low-vacuum line B. This insures a positive and well-balanced system, with the vacuum at the pump reduced to a minimum at all times.

# New Electronic Eye to Measure U. S. Sunfall

Sensitive new electronic eyes developed by Westinghouse engineers to see and record invisible ultraviolet rays in sunshine will soon begin their first daily measurements of "sunfall" in the United States to study its effect on the wartime health of the nation.

First sun metering will get underway soon at Central Park and LaGuardia Field in New York City and in Boston and Cambridge, Mass., to record the amount of ultraviolet which penetrates through the haze of big metropolitan centers. These figures may eventually make it possible to forecast for several days in advance the intensity of sunfall over a city, Weather Bureau officials believe.

Development of a new electronic light cell in the meters will make sunfall measurements as accurate and uniform as the familiar rainfall statistics now issued by the Weather Bureau, according to Dr. H. C. Rentschler, Director of the Westinghouse lamp research laboratories at Bloomfield, New Jersey. Sun tan ultraviolet striking the metal cell will be converted into millionths of watts of energy inside a long glass tube. As it is absorbed in the cell, each quantity of energy will register as a click on an automatic counting machine to give a total amount of radiation for any given period of time.

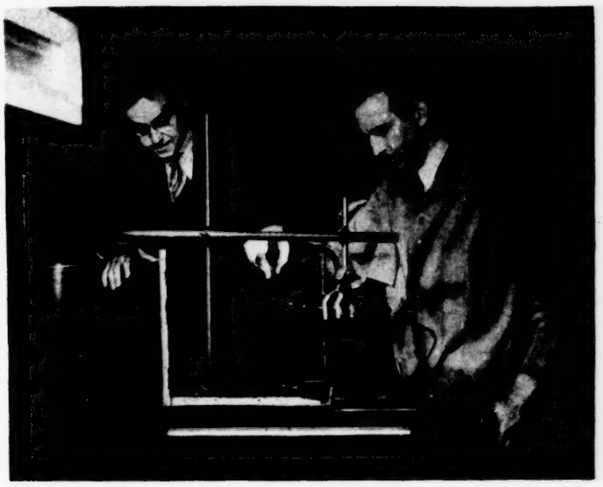
Many of the effects of the sun's invisible ultraviolet rays on human health are still a scientific riddle to research men mainly because of a need for uniform and dependable instruments to measure solar radiations. Electronics research has now produced a tool that will make it possible to meter and standardize a unit of sunlight just as accurately as a watt of electricity or gallon of fluid.

Ultraviolet sunfall measurements will be made available by weather stations to farmers, agricultural colleges, meteorologists and physicians throughout the country. In agricultural studies and crop surveys, solar ultraviolet data may prove as important as soil analysis is now, engineers believe.

In appearance, the ultraviolet sun meter resembles a long, oversized radio tube. At the upper end of the instrument is a flat metal button about the size of a half dollar and surrounded by a circular wire electrode. The metal in its refined state is sensitive only to that portion of the ultraviolet in sunlight which produces sunburn. The sun's rays, striking the surface of the disc in a nearly perfect vacuum, cause the metal to release a stream of photo-electrons which travel to the electrode. This current is so small that it must be expressed in millionths of watts, or microwatts.

From the electrode, photoelectrons pass to a tiny condenser, actually an *electronic bucket* which stores up the energy over a period of seconds and then releases it in a single charge across an electrical circuit in the tube. Each time the condenser discharges its quota of photoelectrons, a sensitive relay *trigger* registers a sharp click which reveals that a known quantity of ultraviolet is reaching the earth. The number and frequency of clicks provide research men with the total quantity for any given period of time.

Work is now under way in the Westinghouse lamp laboratories to build other instruments which will register the intensity of natural daylight and record these data automatically. Eventually it is expected to have these instruments work side by side with the sun meters so that the Weather Bureau in the future can forecast bright days and dull days as readily as rainfall and snow are now forecast.



*Dr. H. C. Rentschler, inventor of the instrument for measuring sunfall and director of the laboratories, watches as D. E. Henry, electronics engineer, exposes the device to invisible sun tan rays.*

# WASHINGTON NEWS

## *Summarized by Loring F. Overman. Details of Air Conditioning "Draft"; Fuel Oil Situation is Tightening; WPB's Heating Branch Transferred.*

As forecast in last month's *Washington News*, November turned out to be a month of feverish activity in the nation's capital. Many of the brewing potions boiled over. Others are bubbling furiously, with announcements anticipated shortly.

Providing the Btu is the actual opening of large-scale military operations in Africa and the broadening of activities in the Pacific. In both of these actions military planners have had forced on them the realization that the building of a military machine, difficult enough in itself, is *a task* dwarfed by the appetite of such a machine actually in operation.

Communication lines from East and West have been kept hot with demands for on-the-spot deliveries of this or that essential materiel. Goaded by these demands, and by the realization that fronts now in operation are only the beginning, the Washington alphabetical team of WPB, OPA, BEW, WMC and others are calling signals for power plays that put civilians on the bench and give the ball to the military.

Officials warn that while the winning touchdown isn't yet in sight the initial yardage gains are such as to warrant speeding up the plays as much as possible now, instead of building slowly up to a peak originally scheduled for late Spring of 1943.

Admitting the squeeze will be sudden and severe on civilian economy and its suppliers, Washington now takes the position that this will be a small price to pay for a quickened victory.

### A.C. Plan Speeded

Plans for the nation's civilian air conditioning equipment to "go to war" developed rapidly under direction of the Air Conditioning Section of the Used Equipment Division of WPB. To date equipment totalling 41,000 horsepower has been transferred from civilian fields to war production plants, and the A.C. unit has on its books requests for the immediate placing of 65,000 additional horsepower.

At present the program for the duration contemplates transfers to the following industries:

| | |
|---|---|
| Synthetic rubber | 40,000 hp. |
| Blast furnaces | 55,000 hp. |
| General manufacturing | 75,000 hp. |
| Food storage | 75,000 hp. |

The food storage category is the latest to be added to the program. There are indications it may become the largest before the end of the war. Decision to add food storage was made recently when it became apparent that bumper crops, lack of cans and other materials for containers, and lack of transportation facilities would result in widespread food spoilage unless some steps were taken to supplement present cold storage facilities.

The food storage phase of the program will start with a campaign to put into service all existing ammonia equipment not now in use. It is reported that a considerable amount of such equipment is available, and only after this has been utilized will efforts be made to "enlist" or "draft" additional equipment.

Several steps directly related to the general plan of utilizing civilian air-conditioning equipment for war purposes have recently been completed in Washington.

1. Neil R. Andrews has been named chief of the Used Equipment branch of WPB, with Don S. Jackson as deputy chief. S. S. Fretz III, Philadelphia, has been named to assist John Jex, Jr., chief of the Air Conditioning section of the branch;

2. Congress was scheduled to give early consideration to a bill authorizing the release of Federally-owned equipment needed for the program; President Roosevelt asked Congress November 30 for a bill giving him broad powers over equipment transfers, but said that the immediate purpose was to facilitate the relocation of air conditioning machinery now in Government buildings.

3. Surveys have been completed showing the location, condition, age and capacity of every commercial installation of over 100 hp. in the country. Hundreds of units have already been volunteered, but under the program the administrators have authority to "draft" equipment needed. Early indications are that exercise of this authority may not be needed. Firms desiring to volunteer equipment or to secure details of the program should write to John Jex, Jr., chief, Air Conditioning Section, Used Equipment Branch, WPB, Washington, D. C.;

4. To implement the program the Office of Price Administration has published price ceilings outlining conditions under which donors will be renumerated for equipment. The ceiling permits payment of original installed cost, less 5% per year depreciation, plus cost of alterations necessitated by the removal of equipment. All removal costs will be borne by the government; and

5. The present plan is to deplete all manufacturers' inventories of existing equipment before drawing heavily upon used equipment. Stressed, however, is the fact that although manufacturers might sell out of stock and then replace raw materials under the Production Requirements Plan, only one such replacement will be permitted. The out-of-inventory purchase phase of the program is planned to absorb all new equipment in existence before launching deeply into conversion of used equipment, but it is not intended to provide for continued manufacturing of new air-conditioning equipment if converted units will do the job.

Representatives of the Used Equipment Air-Conditioning section stress the point that policies of the program contemplate a realistic effort to solve the problem of needed equipment and scarce materials without imposing undue hardships upon either manufacturers of equipment or upon donors. The present program, they contend, offers advantages to both.

While donors will be without the use of equipment for the duration, they will be compensated on the basis of initial installation costs, and will be in a position to replace with new and perhaps more modern equipment at a later date.

Manufacturers, in turn, will not only be permitted to produce specialized equipment for direct military purposes, but will be keeping installation crews and reconditioning units of their plants in operation under the conversion program. In addition, it is pointed out, the conversion program will create a tremendous market for after-the-war replacements.

### Fuel Oil Tighter

Pointing out that already-curtailed East Coast oil and gasoline supplies must now serve two additional areas, the Mediterranean and African, Atlantic coasts, Petroleum Coordinator Harold Ickes urged on November 12 a further voluntary curtailment of

consumption of both gasoline and fuel oil. On the following day the Office of Price Administration ordered additional restrictions in the issuance of fuel oil rations for equipment which may be converted to the use of coal.

As outlined in Amendment 7 to the Fuel Oil Rationing Regulations, oil-burning equipment furnishing heat or heat and hot water for apartments, office buildings, institutions and similar structures will be regarded as convertible to an alternate fuel unless satisfactory proof to the contrary is furnished.

Rations for fuel oil will be issued, as formerly, until conversion is completed, but this grace period now is limited to the end of the second heating period.

Up to the time of issuance of Amendment 7, equipment had not been regarded as convertible if the applicant claimed sufficient materials and labor could not be secured, the cost of conversion was unreasonably high, or an alternate fuel was not available. This arrangement has apparently not proved satisfactory, as local boards do not have sufficient time or information to investigate.

To assure that rations are not allotted to convertible equipment, the local rationing boards in the 30-state limitation area will review all rations issued for heat or heat and hot water to multiple dwellings. In instances where satisfactory proof is not established that conversion is impossible, rations which have been issued for the entire heating year will be revoked and fuel oil allotted only for the period necessary to accomplish conversion.

Local boards will determine whether "satisfactory proof" has been presented, such proof being defined by OPA as instances where "the materials necessary for such conversion are not on hand and that the required labor is not available and that such materials and labor can be obtained only with unreasonable difficulty or expense, or that an alternate fuel is not available."

Because of the more extensive and critical need for conversion of heating boilers from oil to coal, OPA on November 26 revised its price regulation on conversion parts to bring it in line with trade practices established as the new conversion industry has grown to major proportions.

Cost increases, reflecting freight charges at the manufacturer's level and relieving the squeeze on the wholesale and retail levels, will result in an increase of approximately 6% to the household. This will mean an average increase of $1.50 to $2.00 on the conversion parts necessary to convert an oil-fired heating boiler to the use of hand-fired solid fuels.

These changes are contained in Revised Maximum Price Regulation No. 236—Heating Boiler Conversion Parts—issued and effective November 25.

At the same time, certain special new combination conversion units were priced specifically as such at dollars-and-cents maximum prices installed and sales of parts weighing ten pounds or less were excluded from the revised regulation and put under Maximum Price Regulation No. 188, which sets manufacturers' ceiling prices on specified building materials, and the General Maximum Price Regulation. This was done because the new units did not lend themselves to weight pricing and because the sales of ten pounds or less were found to be largely repair rather than conversion sales.

## Conversions Lag

All fuel oil consumers—industrial, commercial and domestic—who plan to convert their facilities to coal should place their coal orders now, Secretary of the Interior Harold L. Ickes said November 30, acting in his joint capacity as Petroleum and Solid Fuels Coordinator. He explained:

"It is particularly important for industrial and commercial consumers to get commitments on coal in order to assure themselves of sufficient quantities when their facilities have been converted. Large users of fuel oil will necessarily use large quantities of coal. Advance planning will prevent hardship.

"While everything possible is being done to speed up construction of the 24-inch oil pipeline from Texas to Illinois, it should be emphasized that this line will do comparatively little to solve oil shortage problems this winter.

"Moreover, tank car shipments to the East Coast are considerably below the hoped-for 900,000-barrel daily mark. In short, we cannot guarantee any specific number of tank cars being moved to this area daily. Nevertheless, this Office, the oil industry, and the railroads are not relaxing to keep the daily figure as high as possible."

Deputy Coordinator Ralph K. Davies said that reliable oil industry surveys show:

"Only 27,000,000 barrels of industrial fuel oils, and 4,203,750 barrels of home heating oils are being saved annually, to date, by conversion to coal or some other alternate fuel in the East Coast area. However, carefully conducted surveys indicate that a total of 57,969,000 barrels of industrial fuel oils and 35,625,000 barrels of home heating oils can be saved annually in the East Coast area by conversions, if all possible conversions are made.

"In the case of many domestic conversions, the question is one of willingness to convert. Of the 35,625,000 barrels annually which are indicated as convertible, 11,400,000 barrels can be saved by consumers who already have on hand all of the materials with which to convert. The remaining 24,225,000 barrels could be saved annually if the consumers would purchase grates or lugs which are available without priority ratings."

To facilitate the granting of priority applications on industrial and commercial conversions, the War Production Board just recently streamlined its operations, Mr. Davies explained.

Purchasers of Class A stokers (grate area of 36 sq ft, or less, and coal-feeding capacity over 60 lb per hour) should fill out WPB Form PD-668 in quadruplicate and mail to the War Production Board, Attention: Henry S. Norris, Plumbing and Heating Branch, Reference: L-75, Washington, D. C.

Applications for coal stokers having a grate area over 36 sq ft, should be made on a WPB Form PD-1A, in duplicate, and mailed to the War Production Board, Attention: PD-1A Unit, Washington, D. C.

Of the 11,000 tons of iron and steel which WPB made available for conversion purposes a short time ago, only 5,000 tons have been used to date, Mr. Davies reported. As soon as the remaining 6,000 tons are used, WPB officials have promised that more iron and steel will be allocated for this use. Mr. Davies added:

"Any industrial users having any trouble whatsoever in obtaining priorities on materials for industrial conversions should contact OPC's Marketing Director, Robert T. Collier, Room 4257 New Interior Department Building, Office of Petroleum Coordinator for War, Washington, D. C.

Although earlier reports indicated a reduction in oil to be allowed, effective in the first period, it was announced on November 29 that rations of fuel oil for heating throughout the 30-State rationed area will continue unchanged for the following five weeks, embracing the second heating period.

Class 1 coupons, used mostly by householders for heat and hot water, will continue to have a value of 10 gallons each and Class 2 coupons, used by apartment houses, commercial establishments, and other volume buyers, continue to be valid for 100 gallons each.

Mr. O'Leary stated that since the weather had been milder than nor-

mal throughout most of the rationed area, householders who have used fuel oil prudently should have a "reserve" to add to their rations when the weather turns colder. He urged continued careful use of oil, since the serious supply situation may prevent increased rations later in the winter.

The second heating period extends from November 30 and December 6 to January 2 to 5, depending on the zone. Coupons for the second heating period are numbered "2" on the coupon sheets.

## Gas Heating Limited

Two limitation orders, L-31 governing natural and mixed gas, and L-174, covering manufactured gas, were issued November 13 by the WPB Power Branch, in an effort to anticipate possible gas shortages in many parts of the country. Principal changes in the order follow:

*L-31 (Natural Gas)*—(1) Restrictions on new deliveries of gas to non-residential customers are made nationwide. Previously the restrictions were limited to certain states. After November 30, WPB approval must be obtained for all new non-residential deliveries of equipment, except in the case of replacement of existing facilities.

(2) In the case of residential customers, the prohibition against new gas deliveries applies after November 30 to all gas heating equipment. Heretofore this prohibition did not affect small unit heaters supplying less than 50% of the heating requirements of the premises.

(3) After November 30, installation of gas equipment by both residential and non-residential consumers is prohibited if the delivery of gas is not permitted under the order. This is intended to prevent a waste of critical materials in the installation of gas equipment which cannot be served because of a limited gas supply.

(4) A curtailment schedule is provided with a view to protecting war producers and essential civilian services in time of shortage. Whenever necessary the Director General for Operation is authorized to require gas companies to curtail deliveries to residential consumers.

*L-174 (Manufactured Gas)* — This order has been amended to conform closely to the new provisions of the natural gas order. The principal change is to prohibit the installation of gas equipment in cases where delivery of gas to such equipment is prohibited under the order. In addition the amendment provides for the submission to WPB of curtailment schedules in advance of anticipated shortages.

In addition to the areas listed in the amended orders, a further revision of L-31 on November 24 added sections of Kansas, Utah and Wyoming.

## Boiler Orders

Two orders affecting cast iron boilers were issued during the month, one by WPB, the other by OPA.

The WPB order extended until December 1 the date when manufacturers must discontinue manufacture of low pressure cast iron boilers using exclusively gas or exclusively oil for fuel.

The OPA order, issued November 18, fixed maximum prices for cast-iron coal-burning and oil-burning boilers and for radiators. Prices generally 5% below prevailing prices were fixed for boilers, while 12% reductions were fixed for radiators.

The price reduction, through issuance of Maximum Price Regulation No. 272, effective November 23, affects an industry which last year shipped 301,000,000 lb of boilers and 89,000,000 sq ft of radiation. Studies showed a weighted price increase of approximately 24% for the sale of all series of coal and oil-burning boilers from February, 1940, through January, 1942. From the beginning of January, 1940, to January, 1942, list prices for radiation had increased 25%.

## Repairs AA-1

While busily issuing orders preventing manufacturing plants from producing many things, WPB appears convinced of the advisability of keeping plants in tip-top shape and ready to start manufacture at a moment's notice. This recognition is embodied in authorization, on November 11 by the WPB Requirements Committee, of the application of AA-1 priority ratings to essential repair and maintenance.

Included in the scope of the determination, which becomes a basic policy for the first quarter of 1943, are essential repairs and maintenance for productive facilities, utilities, housing and consumers' durable goods.

"The action," says WPB, "will make it possible for vital plants and factories, mines and refineries and other industrial facilities to continue effective production of both munitions of war and essential civilian goods. Communications and transportation systems, gas, oil and water lines and other services will be assured of materials to keep them performing their essential functions. Supplies and materials needed for essential maintenance and repair for housing may also be obtained."

## WPB Streamlined

The Plumbing and Heating branch of WPB became the P&L *Division* of the Construction and Utilities Bureau under a WPB reorganization announced November 17. Air Conditioning and Commercial Refrigeration remain as a section under the General Industrial Equipment division of the Equipment Bureau.

Latest streamlining of WPB groups 36 industry branches under five bureaus. In the shuffle the most important change is that WPB groups making and applying programs to distribute materials are merged to provide a more closely knit organization to administer WPB policies, including the newly announced Controlled Materials Plan. (CMP)

The new CMP, which will begin operation with the second quarter of 1943, will at first affect only steel, copper and aluminum. In theory the plan seeks to iron out rough spots of the present Priorities System by permitting the placing of only such orders as there are materials available, and by scheduling deliveries to arrive at the time they are needed instead of months before, or months too late.

Under CMP, prime contractors will assemble "bills of material" needed to complete a contract, together with a schedule of dates specifying when the material must be delivered. Included in the bills of materials will be those materials needed by the prime contractor, his subcontractors and their suppliers. Each prime contractor submits his bill of materials to the claimant agency with which he is negotiating—Army, Navy, Maritime Commission, aircraft scheduling unit, Board of Economic Warfare, Lend-Lease, and Office of Civilian Supply.

Each claimant agency will assemble its various bills of materials and submit them to the WPB requirements committee and to the respective controlled materials divisions. When the sum of these various requirements has been adjusted to supply, WPB will allocate authorized quantities to each claimant agency.

Claimant agencies, in turn, distribute these broad allotments to their prime contractors by means of "allotment numbers", which prime contractors pass along to sub-contractors as needed to secure supplies. Allotment numbers constitute "certified checks" for specific amounts of material for delivery during specific periods.

## Ordnance Plant Stopped

Acting under the policy of curtailing the use of materials for construction projects, WPB ordered on November 27 the immediate stoppage of all work incidental to the construction and equipment of the $45 million expansion for the Continental Ordnance Plant at Hammond, Ind.

# Peat Has Possibilities as an Emergency Fuel

THERE are 121,000,000 tons of peat fuel waiting to be dug out of the swamps of New England, according to Professor Crabtree of Tufts College, who is working with the University of New Hampshire to develop a means of making this vast supply available for this winter as well as future winter seasons.

According to figures of the United States Geological Survey, there are 100,000,000 tons in Maine; 1,000,000 tons in New Hampshire; 12,000,000 tons in Massachusetts; and 8,000,000 tons in Vermont, all readily accessible to peat diggers. Although Ireland, Russia, Germany and Holland use it extensively, there have been only feeble efforts made to develop the vast New England supply and put it to use.

There is no sound reason, according to Professor Crabtree, why the nation cannot use this peat in its industrial plants and thus save several thousand carloads of coal as well as the cars used in hauling the coal, the cars meanwhile being put to some other important use. Attempts were made to use peat in the New England states during the first World War, but were not successful because the proper methods of going about the job had not been determined. In the past twenty years scientists have learned so much about peat that its widespread use in New England as an emergency fuel is now feasible in every respect and should be encouraged.

### What Peat is

Peat is the partly carbonized residue of grasses, sedges, water lilies and other swamp plants which grew about 25,000 years ago. In order words, it is plant material about half way to becoming coal. Because of the acidity of the pond water in which they grew, the bacteria which normally rot plant fibers to nothing in a few years, could not do their work, and so the material collected, and gradually, by chemical action, turned partly to carbon. Through the centuries these layers piled up on each other and turned the shallower ponds to swamps, so that today, under the swamp water, grasses and water lilies, we have twenty to thirty feet of solid peat, waiting to be dug and burned.

Geological survey tests show that air-dried machine peat has 7290 Btu per pound, against 5660 for hard wood and 13,000 for anthracite. Professor Crabtree thinks there would be no difficulty in using peat for factory furnaces and steam electric generating plants, because such places keep firemen on duty all night and the fires could easily be replenished. On the other hand, household fireboxes would not be large enough to keep a peat fire going all night.

Today the northern half of Russia burns peat instead of coal in factory furnaces and to make steam for electric generating plants. The Germans did so well with peat that in 1936 and for a time thereafter they sold their peat in the British market in competition with British coal. In 1940 and thereafter, Irish cities burned 3,000,000 tons of peat annually, many users preferring it to coal.

The Irish and Scottish method of draining the little bogs and cutting out the peat in blocks will not work in this country, because it is too expensive, due to the high labor cost.

### How Used Elsewhere

Our early attempts with peat were failures because we tried to squeeze out the water mechanically. This cannot be done satisfactorily. Professor Crabtree believes that if we adopt the German method, peat can be produced in New England for about $6 a ton or less, on volume production. A dredge with a caterpillar tractor, or a floating dredge or dragline could be used, according to conditions. After this the problem would be to get rid of the water, as peat produces only 200 pounds of dry fuel to a ton, the rest being water. The peat is in colloidal form, and pressing alone will not take out the water.

The Germans, and the Russians, also, put the peat through a macerator, after the free water has been drained out, this macerator being a very simple mill that grinds the peat up into a "soup." This is then allowed to flow out, eight inches deep, onto a hard surface of wood or concrete, to dry in the summer sun. Evaporation converts the mixture into a semi-solid sludge which is then cut into convenient blocks by machine operated knives attached to a tractor and operating in sets both vertically and horizontally. Drying is continued, the shrinking action breaking the bricks apart into hard lumps, which are gathered up and are ready to be burned by industrial plants, making an excellent fuel. While the fuel thus obtained has only about half the heating value of hard coal, this value is greater than that of hard wood; and the fuel, being so cheap and easily obtained, as well as easily hand or stoker fired, would be especially valuable in the smaller industrial plants, since they would be near the sources of supply and would not need to have large fuel piles.

The Canadian government has spent $200,000 in Ontario, where peat bogs are extensive, learning how to produce peat economically and how to burn it in industrial establishments. Peat fuel is now produced there at $4 at ton. Professor Crabtree thinks that twenty or more local peat cutting and drying plants could easily be supported by a good industrial demand because of the advantages which peat offers under present conditions.

He points out that bog peat should not be confused with peat moss, or sphagnum, largely used by horticulturalists, which grows on top of peat bogs to a depth of about two feet and has not been carbonized to any extent.

# NEWS OF THE MONTH

## ASHVE to Meet in Cincinnati for 49th Annual Meeting

CINCINNATI—The 49th annual meeting of the American Society of Heating and Ventilating Engineers, to be held here Jan. 25-27, will provide a forum for the exchange of vital engineering information. Headquarters will be the Hotel Gibson.

The meetings committee has prepared a streamlined program which includes subjects of wartime interest, such as fuel conservation, food dehydration, man-power problems, warship ventilation and physiological studies affecting efficiency and health. A special panel discussion of the subject "How to Keep Fit in Cold Homes" will be a feature of one session.

Four technical sessions will be held, commencing on Monday morning, January 25, and there will be several research papers covering studies of heating plant operation with reduced night temperatures, resistance of various building materials to vapor transmission, and performance of air duct outlets. The technical program follows:

JANUARY 25—9:30 A.M.

"Warship Ventilation System Design," by T. H. Urdahl and W. C. Whittlesey.

"Modern Methods of Food Dehydration."

NOON

Luncheon—Speaker, Dr. B. M. Woods, University of California, "The Manpower Problem in Engineering."

2 P.M.

"Army Fuel Consumption Studies," by McCabe, S. Konzo and Biller.

"Performance Characteristics of a Conventional Coal-Fired Space Heater," by R. C. Cross.

"Residence Heating Operation with Reduced Night Temperatures," A. P. Kratz, Harris and M. K. Fahnestock.

JANUARY 26—9:30 A.M.

"Comparative Resistance to Vapor Transmission of Various Building Materials," L. V. Teesdale.

"Summer Comfort Factors as Influenced by the Thermal Properties of Building Materials," by C. O. Mackey and L. T. Wright, Jr.

"Friction Heads due to Water Flow in Copper, Brass and Other Smooth Pipes," by F. E. Giesecke.

"Performance of Side Outlets on Horizontal Ducts," by D. W. Nelson and Smedberg.

2 P.M.

Panel Discussion—"How to Keep Fit in Cold Homes," conducted by Dr. C.-E. A. Winslow.

## Prof. Holt Discusses Fuel Saving

CAMBRIDGE, MASS.—In a talk given before the Massachusetts chapter of the ASHVE at its Nov. 17th meeting at Graduate House, Massachusetts Institute of Technology, Professor James Holt of the Mechanical Engineering Department of the Institute, told how it will be possible to maintain public health even with a sharply reduced fuel supply. Based largely on experiences and experiments in his own home, he declared that 75% of fuel users can save sufficient fuel to get by for the winter, if they take ordinary, commonsense means to prevent heat loss.

Heat loss of the average house from infiltration of cold air, he stated, is around 27%; conduction loss through glass 28%; through walls 27%, the roof 16%, and the floor 2%. The average house today is a very leaky structure and cold air infiltration in most cases is far in excess of actual ventilation requirements. Weatherstripping quite often will save 10% of the total loss, and storm sash 31% of the glass loss.

## Ontario Chapter of ASHVE Meets

TORONTO, ONT. — The November meeting of the Ontario chapter of ASHVE was held recently in the Royal York Hotel with numerous members and guests present. The feature of the evening was an address by A. S. Morgan on "Fuel Oil and Its Limitation During Wartime." A symposium on the subject of air cleaning was conducted by three speakers, W. B. Firner, R. Taylor of Darling Brothers, Toronto; and O. Moffat of the Canadian Westinghouse Co., Hamilton. A discussion of air filters followed.

President D. O. Price, presided. Attention is to be given to the subject of food dehydration at the December meeting.

### FORD WILLOW RUN BOMBER PLANT

AEROFIN CORPORATION, *Syracuse, N. Y., furnished the non-freeze coils in the Willow Run project described in the October, 1942 issue of* HEATING AND VENTILATING. *The caption of the illustration on page 30 of that issue was in error in crediting these coils to The Trane Company. The mistake was that of the editor and not of the author, G. S. Whittaker.*

## Coal Group Gets More Support

NEW YORK—"Operating companies representing more than 80% of the total commercial production, based on Schedule A, have signed agreements to support a considerably enlarged program," stated Frank W. Earnest, Jr., president of Anthracite Industries, Inc., November 10. "Other companies representing an additional 10% of the tonnage have notified Anthracite Industries that they are considering the matter of membership at their board meetings this month, which would bring the participation to above 90%.

"Immediate steps are now being planned to launch the largest research program ever undertaken by the Anthracite Industry. One of our immediate major objectives is the development of inexpensive auxiliary equipment to improve the efficiency and convenience of the millions of pieces of equipment now using anthracite. In cooperation with equipment manufacturers, we also plan to develop, design and improve boilers, furnaces, tank heaters, stokers and other types of equipment. Through this effort the industry will be prepared to take its proper place in the post-war period with equipment to challenge all other fuels during the expected era of extensive new building that is certain to exist."

## Oil Institute Elects Officers

BOSTON—At the organization meeting of the Oil Heating Institute of New England, the following officers were chosen: President, William J. Gilbane, Pawtucket, R. I.; vice president, John P. Hobbs, Malden, Mass.; secretary-treasurer, Fred N. Beckwith, Boston. Directors chosen were: J. Henry Brody and Don. J. Edwards, Boston; John Flynn, Fall River; William Gilbane; Clarence G. Gurney, Leominster, Mass.; Robert S. Hopkins, Hartford; John F. Walsh, Roslindale, Mass.; Ivan S. Sutherland, Lynn, Mass.; Everett L. Wolfe, Brockton, Mass.

## Winslow Honored by A.P.H.A.

ST. LOUIS—Dr. C.-E. A. Winslow, of Yale University School of Medicine, was awarded the Sedgwick Memorial Medal, given annually by the American Public Health Association for distinguished service in public health, at the meeting of the Association here late in October.

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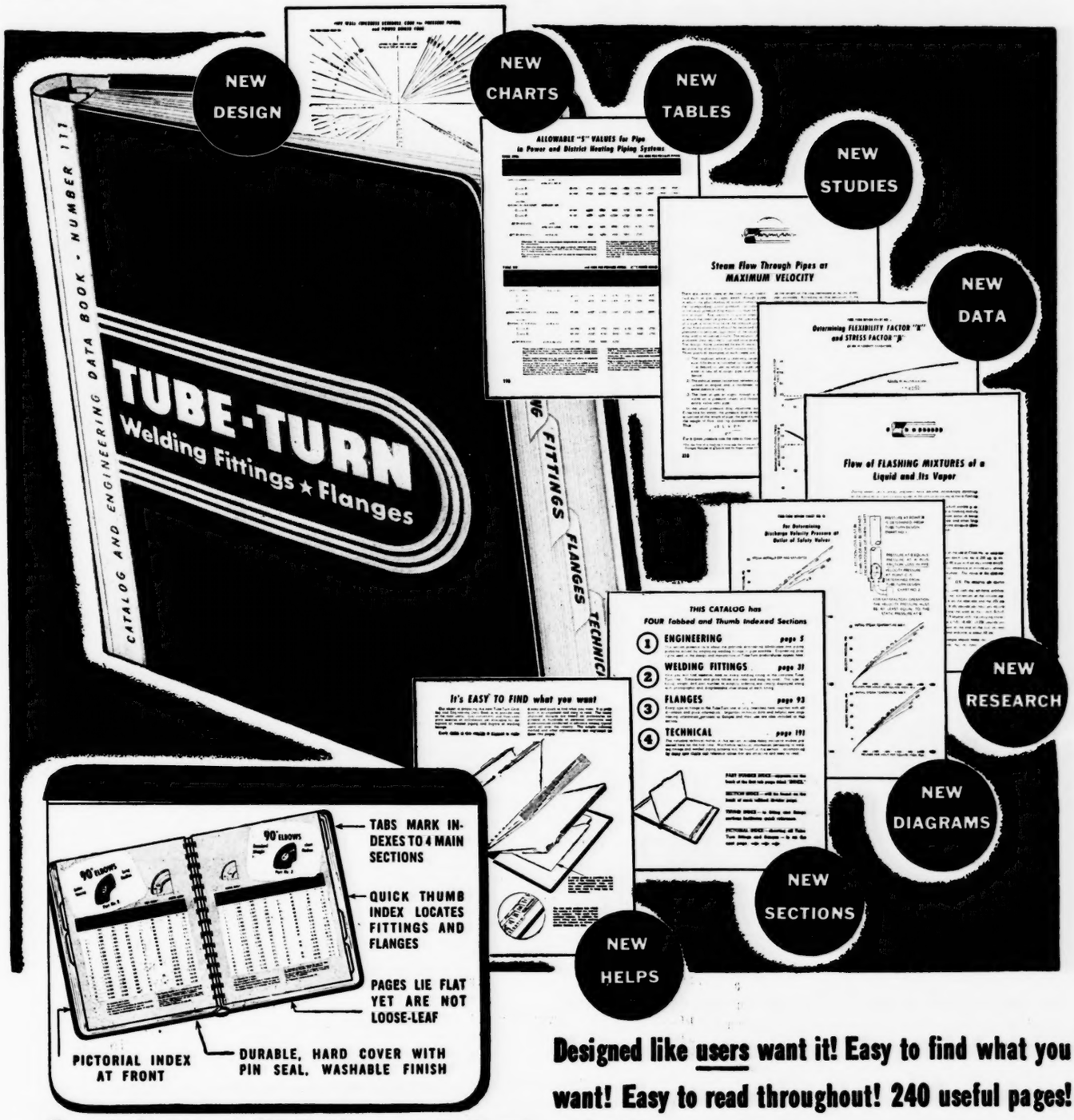
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## M.I.T. Coal Conversion Balked

CAMBRIDGE, MASS.—The Massachusetts Institute of Technology has been trying vainly since March 26 to convert its heating plant from oil to coal, so as to make available for other users some 1,430,000 gallons of oil. In the process the Institute has appropriated $40,000 for conversion, has bought coal and done everything else possible, but in spite of the best efforts of local WPB officials has gotten nowhere. Action now seems unlikely before next spring.

Last year the Institute used 2,300,000 gallons of bunker oil and it is believed that under the conversion plan, 1,143,000 gallons would be saved. The portion of the installation converted to coal would be expected to take care of ordinary needs except in the severest winter weather. At this time the remaining oil burning units would be cut in to supplement the coal for the generation of steam. Under priorities received, the college had ordered stokers, repair parts for a coal loader, and combustion parts, but its priority rating was too low, under a WPB restriction order issued October 13 to get delivery. Since that time school officials have been trying to get a higher rating in order to get delivery of the equipment, but have met with no success even though the Institute is engaged 100% in war research for various government agencies and has its entire technical training program for engineers and scientists geared to the demand for men in the war effort, besides giving special courses to thousands of Army and Navy officers.

## To Study Wet Wall Heat Loss

NEW YORK—R. H. Dearborn, dean of the School of Engineering at Oregon State College, Corvallis, and F. C. McIntosh, Pittsburgh, chairman of the Committee on Research of the ASHVE, have consummated a cooperative agreement to investigate the heat flow through wet building walls.

The research program will be carried on in the domestic heating laboratory of the College at Corvallis by means of a specially constructed apparatus in a study jointly planned by Prof. Earl C. Willey of the College and the research committee of the Oregon chapter of the Society, of which Edwin W. Neubauer of Portland is chairman. Various types of building wall sections will be constructed and tested under conditions simulating heat loss during rainy weather.

## Refrigeration Held Essential by Conference in Chicago

CHICAGO—Definite proposals towards gaining a greater degree of consideration for the material and manpower requirements of the refrigeration industry were made at the All-Industry Conference on Refrigeration, held here Nov. 19-20, and devoted to stressing the importance of refrigeration to the war effort as well as to essential needs.

One of these proposals dealt with the setting up of machinery to obtain estimates of the probable amounts of critical materials needed during the coming year to keep the industry's repair and maintenance facilities for essential installations operating.

The importance of the materials shortage and the critical manpower situation upon refrigeration maintenance and repairs was emphasized by E. A. Plesskott, national president of the Refrigeration Service Engineers Society.

A feature of the Conference was the presentation of reports from product manufacturing groups. The consensus of these was that compressor parts, including compressor bodies, are available from manufacturers on an A-10 Rating under P-100, or on a rating as established for emergency repairs under P-126. Controls are difficult to supply except on very highly rated orders, with the position of commercial controls somewhat better than those for household systems. In this connection it was noted that valve manufacturers are making deliveries on lower-rated orders than are others, which was explained by the fact that the manufacturers thus delivering on low-rated orders had no large volume of highly-rated orders.

The spokesman for the valves, fittings and accessories group stated that WPB would probably submit a list of these items that it will still permit to be manufactured, the probability being that only standard items will be produced.

It was brought out that certain supply items such as refrigerators, belts, compressor oil, small amounts of copper sweat fittings, and some brass fittings, still can be had without priorities. The scarcity of cylinders, however, complicates the refrigerant supply, and containers for oil also are difficult to get and it may be necessary to use glass bottles.

The All-Industry Conference was sponsored jointly by The Refrigeration Equipment Manufacturers Association, National Refrigeration Supply Jobbers Association, and Refrigeration Service Engineers Society.

## Ventilating Errors Pointed Out

PITTSBURGH—Failure to provide adequate air to compensate for that removed by exhaust systems is one of the most frequent violations of good ventilating practice in industry, according to Dr. Francis R. Holden, Industrial Hygienist of the Industrial Hygiene Foundation, in a paper presented at the seventh annual meeting of the Foundation at Mellon Institute Nov. 10. Such a fundamental error is especially important and noticeable in winter when windows and doors are closed, and when the resulting below-atmosphere pressure created in a room greatly restricts the performance of exhaust systems, he said.

Another serious error which often accompanies this condition, Dr. Holden stated, is the location of toxic fume exhaust fan discharges near windows or roof ventilators, so that poisonous or obnoxious vapors discharged at one point are actually sucked back into the room at another. He pointed out that at least as much air should be provided as will be exhausted and that exhaust vents should be carefully located to prevent recirculation of fumes back into the room. The make-up air should be conditioned for winter operation, or to meet any other special requirements.

Also discussed were the use of respirators and various other subjects bearing on the safety aspects of industrial ventilation.

## Bennet B. Bristol

FALMOUTH HEIGHTS, MASS.—Bennet B. Bristol, who with his brother Edgar H. Bristol in 1908 founded the Industrial Instrument Company, which later became The Foxboro Company, died at his summer home here, November 10, following several months' convalescence from a heart attack, suffered last May.

Mr. Bristol was born in Naugatuck, Conn., May 3, 1868. In 1893 he graduated in mechanical engineering from the Stevens Institute of Technology. Throughout the history of The Foxboro Company he served as its treasurer and clerk. He was President of the Foxboro National Bank, a director of the Citizens and Manufacturers National Bank of Waterbury, Conn., chairman of the board of trustees of the Foxboro State Hospital, and took an active part in the affairs of his church and community. He is survived by a brother and a sister, his widow, his six children and nineteen grandchildren.

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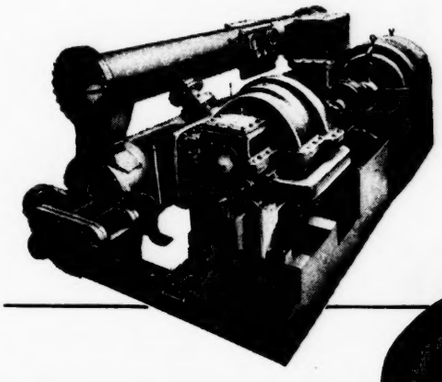

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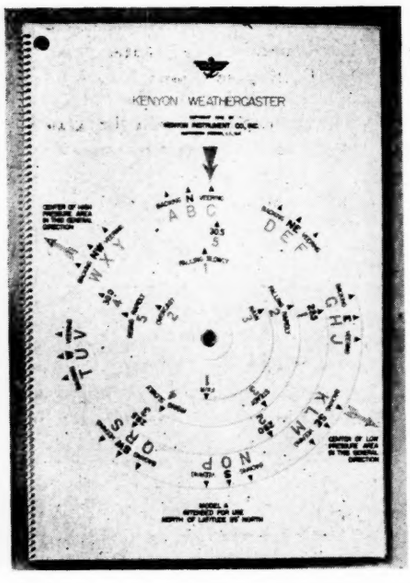
### Steam Generator

NAME—Lodi Steam Generator.
PURPOSE—For rapid steam generation, particularly in intermittent applications.
FEATURES—With only three moving parts, remarkable simplicity and reliability are claimed for this generator. A system of water feeding termed jet control automatically, and without the use of thermostats or motor-driven pumps, furnishes feed water in direct proportion to the amount drawn off as steam, according to the manufacturer. Once the generator has been lighted it is completely operated by the steam throttle valve, or load. Unit is shipped complete, ready for operation when furnished with fuel and water. No pit is required, and no fire-boxes or electrical connections need be installed. Burners can be provided for either gas or oil fuel. A continuous over-lapping coil tested at 1000 lbs. pressure is claimed to make the generator explosion-proof.
SIZES AND CAPACITIES—The 10 hp model is guaranteed to develop 150 lbs pressure from cold start within 5 minutes. Other models up to 70 hp to be produced.
MADE BY—*Super Mold Corporation, Lodi, Calif.*

### Kenyon Weathercaster

NAME—Kenyon Weathercaster.
PURPOSE — For making weather forecasts.
FEATURES — An ingenious device consisting of four concentric movable dials mounted on the front of a spirally-bound, plastic-covered booklet containing instructions, code numbers, and their interpretation. The dials are set depending on the wind direction, barometric reading, direction and rate of change of barometer, and present weather. When dials are so adjusted a code letter and number automatically is formed on the dials, which is interpreted according to the code tables in the booklet. Device, which is quite simple and easy to use, can be applied to predict the probable weather for the next 12 to 24 hours within a radius of 30 to 50 miles. User needs only a barometer. Booklet is 6½ by 9½ in. Price, $4.95.
MADE BY—*Kenyon Instrument Co., Inc., Huntington Station, N. Y.*




### Test Chamber

NAME—Tenneyzphere high altitude test chamber.
PURPOSE—For testing instruments under high altitude conditions.
FEATURES—Insulated to maintain sub-zero temperatures and built to withstand atmospheric pressure, this new test chamber provides atmospheric conditions equivalent to 50,000 ft of altitude. Pressure can be changed as desired by a direct-connected motor-driven rotary vacuum pump which is mounted on the unit and runs continuously during operations. Cooling is secured either by evaporation of Freon in a direct expansion coil or by circulation of an organic liquid cooled with dry ice, depending upon the use to which the cabinet is to be put. Humidity is produced as desired by spraying water into the air stream.
SIZES AND CAPACITIES—Standard apparatus has range of —70 to 140F.
MADE BY—*Tenney Engineering, Inc., 8 Elm St., Montclair, N. J.*

### Dehumidifying Powder

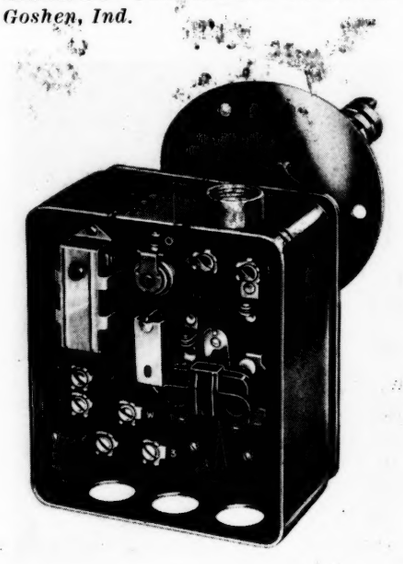
NAME—Dri-Air Chemical Powder.
PURPOSE — For the absorption of excessive moisture from air in enclosed spaces.
FEATURES—The material is a hygroscopic powder which is hung in double mesh bags holding about ten pounds each. The moisture absorbed from the air gathers on the powder and drips off into a container below the bag, dissolving and carrying some of the powder with it. One unit is sufficient to remove excess moisture from about 1000 to 1200 cubic feet of air. Musty odors and damage caused by condensation, rust and mildew, are said to be prevented.
MADE BY — *Tamms Silica Co., Chicago, Ill.*

### New Plastic

NAME—Vinsol.
PURPOSE—To replace steel or other scarce metals.
FEATURES—This new structural resin plastic consists of cellulosic fibers treated with Vinsol, a resin powder. The resulting product is a thermoplastic, fibrous-resin composition said to be hard, dense, stiff but with reasonable toughness, and to be sturdy but light in weight, with a low water absorption and a high resistance to petroleum products. Fibers used in the production process include newsprint, clean cotton rags, and the like. Possible applications for the new product include pipe, wall panels, refrigerators, air conditioning ducts and vent pipes.
AVAILABLE FROM—*Hercules Powder Company, Wilmington, Del., in conjunction with The Patent & Licensing Corp., 30 Rockefeller Plaza, New York.*

### Direct Current Stack Switch

NAME—Type 647 or 648 Direct Current Stack Switch.
PURPOSE—Type 647 for continuous ignition, and Type 648 for intermittent ignition.
FEATURES — Automatically locks out in case of combustion or flame failure and automatically recycles on power failure. Trip free lock-out switch cannot be locked in closed position.
SIZES AND CAPACITIES — Load contacts rated for ½ H.P. 115 volts or ¼ H.P. 230 volts D.C.
MADE BY—*Penn Electric Switch Co., Goshen, Ind.*



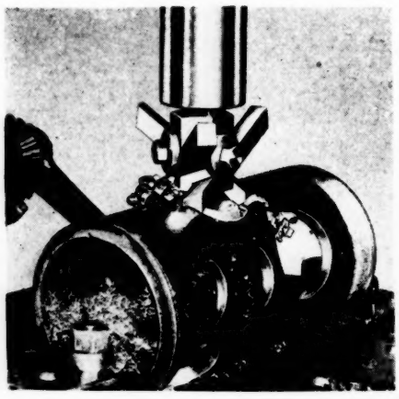
★ As the war goes on, the American engineer looks better and better. He has done some resoundingly important things, that may even dictate the future of the world.

He is an old friend of ours and we are glad to see him the center of admiration. For nearly 30 years we have worked with him adapting laminated plastic material to electrical insulation, mechanical and chemical uses.

Together we have produced better airplane pulleys and machined parts, better instrument panels, better insulation for ignition, radio and all types of electrical circuits, better rayon equipment and plating parts.

Now, in war, we are doing together things we didn't know how to do before, but which will be available and valuable when the last gun has been silenced.

FORMICA
INSULATION COMPANY
4676 SPRING GROVE AVENUE
CINCINNATI, OHIO



## Adjustable Hole Cutter

NAME — Clark Three-blade Adjustable Hole Cutter.
PURPOSE—For cutting round holes in pipe and in sheet material.
FEATURES—Cutter has a heat treated shank, precision ground high-speed tool bits, and removable hardened and ground pilot. A lead drill can be used instead of the pilot if desired. Can be used with electric drills, pneumatic motors, drill presses, lathes, milling machines, or wherever Morse taper or straight shank tools can be used. Metals, plastics, hard fibers, press board or wood, can be cut quickly and cleanly, according to the manufacturer.
SIZES AND CAPACITIES—Range of hole diameters ¾ in. to 4½ in. in thicknesses up to ¾ in..
MADE BY—*Robert H. Clark Co., 3424 Sunset Blvd., Los Angeles, Calif.*

## Air Circulator

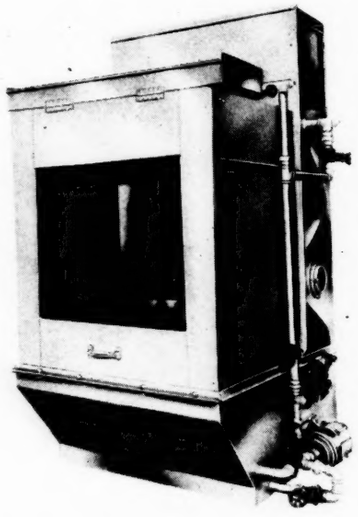
NAME—RECO heat circulator.
PURPOSE—To secure uniform temperature by improving air circulation.
FEATURES—Consists of an axial flow fan suspended from the ceiling with the discharge directed upward against the ceiling. This arrangement causes an outward flow in all directions, with warm ceiling air thus forced over against the walls and downward to the floor. The result is said to be uniform temperature throughout the room, with essentially reduced fuel consumption. Assembly rooms, school rooms, churches, and other structures requiring only occasional heat, are claimed to be much more rapidly heated with the circulator. Units operate on 110 volt, 60 cycle current. Motors are of three-speed type.
SIZES AND CAPACITIES—Propeller blades 20 and 24 in.
MADE BY—*Reynolds Electric Company, 2650 W. Congress Street, Chicago, Ill.*

## Rotary Air Motor

NAME—Gast rotary air motor.
PURPOSE—For power requirements, especially in explosive atmospheres.
FEATURES — Employing the same basic rotary principle used in the company's vacuum pumps and compressors, the following features are claimed for this air motor: (1) No reciprocating parts or springs, (2) automatic take-up for wear, (3) low maintenance—cannot be burned out, (4) positive starting in any position, and (5) exceptional compactness for power developed. All motors fitted with ball-bearings, and parts accurately ground; self-adjusting shaft seals used in place of packing.
SIZES—From 1/20th to 1 hp.
MADE BY — *Gast Mfg. Corporation, Benton Harbor, Mich.*

## Spray Booth

NAME—Aqua-Restor Water Wash Paint Spray Booth.
PURPOSE—For spray painting.
FEATURES—Has rear and side water-impingement walls, which are said to effectively catch and remove paint over-spray, and to give a high percentage of pigment reclamation. Since no spray nozzles are used, clogging is said to be eliminated, and horsepower required for pumping to be low. Unit illustrated equipped with turntable and fluorescent lighting, available in single or multiple units.
SIZES AND CAPACITIES—Units other than that shown are engineered to meet specification requirements. Bulletins available direct from the manufacturer.



MADE BY—*Aqua-Restor Division, Mayer Mfg. Corporation, 45 Division Place, Brooklyn, N. Y.*

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933, OF HEATING AND VENTILATING, published monthly at New York, N. Y., for October 1, 1942.
State of New York, County of New York, ss.:
Before me, a Notary Public in and for the State and County aforesaid, personally appeared Edgar A. Becker, who, having been duly sworn according to law, deposes and says that he is the Treasurer of The Industrial Press, publishers of HEATING AND VENTILATING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:
1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, The Industrial Press, 140-148 Lafayette St., New York, N. Y.
Editor, Clifford Strock, 140-148 Lafayette St., New York, N. Y.
Managing Editor, none.
Business Managers, Robert B. Luchars, 140-148 Lafayette St., New York, N. Y.; Edgar A. Becker, 140-148 Lafayette St., New York, N. Y.; Erik Oberg, 140-148 Lafayette St., New York, N. Y.
2. That the owner is:
The Industrial Press, 140-148 Lafayette St., New York, N. Y.; Erik Oberg, 140-148 Lafayette St., New York, N. Y.; Robert B. Luchars, 140-148 Lafayette St., New York, N. Y.; Edgar A. Becker, 140-148 Lafayette St., New York, N. Y.; Laura A. Brownell, 140-148 Lafayette St., New York, N. Y.; Franklin D. Jones, 140-148 Lafayette St., New York, N. Y.; First National Bank and Trust Co. of Montclair and Robert B. Luchars, Trustees (Beneficiaries unknown), Upper Montclair, N. J.; First National Bank and Trust Co. of Montclair and Leigh Roy Urban, Trustees (Beneficiaries unknown), Upper Montclair, N. J.; First National Bank and Trust Co. of Montclair and Kenneth D. Ketchum, Trustees (Beneficiaries unknown), Upper Montclair, N. J. Paterson Savings Institution, Trustee (Beneficiaries unknown), Paterson, N. J.
3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are:
Laura A. Brownell, 140-148 Lafayette St., New York, N. Y.; John Connolly, 140-148 Lafayette St., New York, N. Y.; Franklin D. Jones, 140-148 Lafayette St., New York, N. Y.; Robert B. Luchars, 140-148 Lafayette St., New York, N. Y.; Louis Pelletier, 140-148 Lafayette St., New York, N. Y.; Elizabeth Y. Urban, 163 Western Drive, Longmeadow, Mass.; Helen L. Ketchum, King St., Cohasset, Mass.; Wilbert A. Mitchell, 28 Harlow Road, Springfield, Vt.; Henry V. Oberg, 1317 Hill Crest Road, R.D. No. 1, Lancaster, Pa.
4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and the affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.
EDGAR A. BECKER, Treasurer.
Sworn to and subscribed before me this 30th day of September, 1942.
CHARLES P. ABEL.
Notary Public, Kings County No. 313; Kings Register's No. 3109; N. Y. County No. 231; N. Y. Register's No. 3-A-161. My commission expires March 30, 1943.

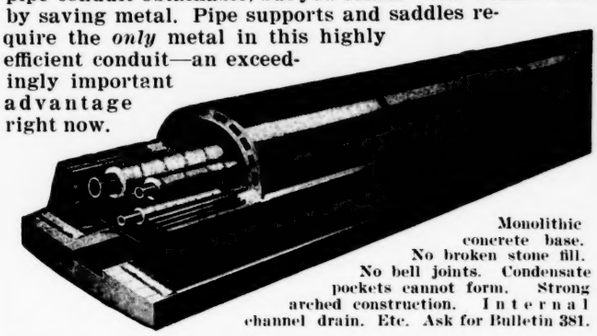
## ? *Why waste metal needlessly? . . The amount of metal in* ?

# THERM-O-TILE

*Reg. U. S. Pat. Off.*

**Underground Conduit is Practically Nil**

When you specify Therm-O-Tile you get not only the simplest, strongest, and most complete underground pipe conduit obtainable, but you HELP WIN THE WAR by saving metal. Pipe supports and saddles require the *only* metal in this highly efficient conduit—an exceedingly important advantage right now.



Monolithic concrete base. No broken stone fill. No bell joints. Condensate pockets cannot form. Strong arched construction. Internal channel drain. Etc. Ask for Bulletin 381.

*Sold and installed by Johns-Manville Construction Units in all Principal Cities. See our page in Sweet's or The Heating Guide.*

## H. W. PORTER & CO., Inc.

**823-V Frelinghuysen Ave., Newark, New Jersey**

Without obligating us in any way, ☐ Please send Bulletin 381. ☐ Send representative. ☐ Enclosed is a sketch, with principal data of a prospective job, on which we shall be glad to have your ☐ comments, ☐ quotations.

**Write your name, firm, and address on the margin of this page, tear out with the checked squares above, mail, and you will hear from us promptly.**

# AIR CONDITIONING NOZZLES

**Nozzles of unique Yarway Involute Design.**

**No internal parts or vanes to clog or erode.**

**Insure trouble-free air washing service.**

**Sizes and types for all requirements.**

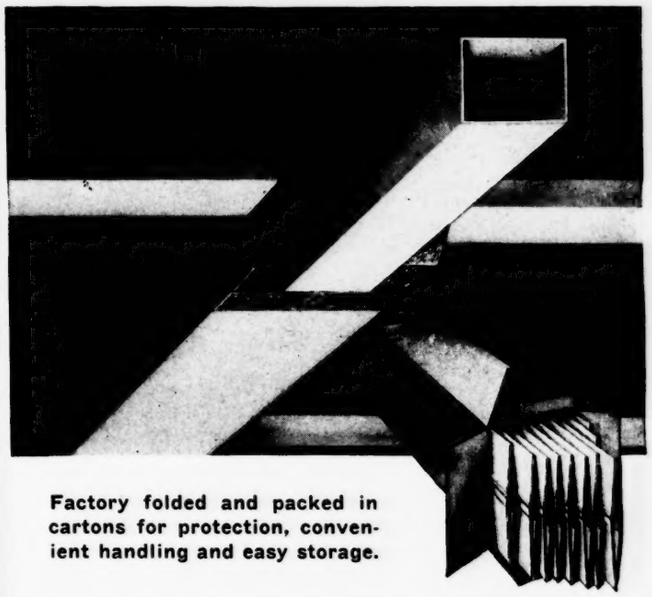
**Many large users—installations total more than 5 million gallons per minute in water cooling and air conditioning service. Write for Bulletin N-615.**

**YARNALL-WARING COMPANY**
**104 MERMAID AVENUE**
**PHILADELPHIA**

YARWAY

# S-S-D
# SAL-MO SUPPLY DUCT

**NEW NON-METALLIC MATERIAL FOR SUPPLY AND RETURN DUCTS**



**Factory folded and packed in cartons for protection, convenient handling and easy storage.**

SAL-MO Supply Duct (S-S-D) is the new conduit material for constructing both supply and return ducts for warm air heating, ventilating and air conditioning systems. It saves metal, permitting many installations that would otherwise be impossible because of the metal shortage.

Ducts . . . both supply and return . . . made from S-S-D are safe, insulated and fuel saving. Leading independent laboratories have proved that S-S-D possesses a wide margin of safety.

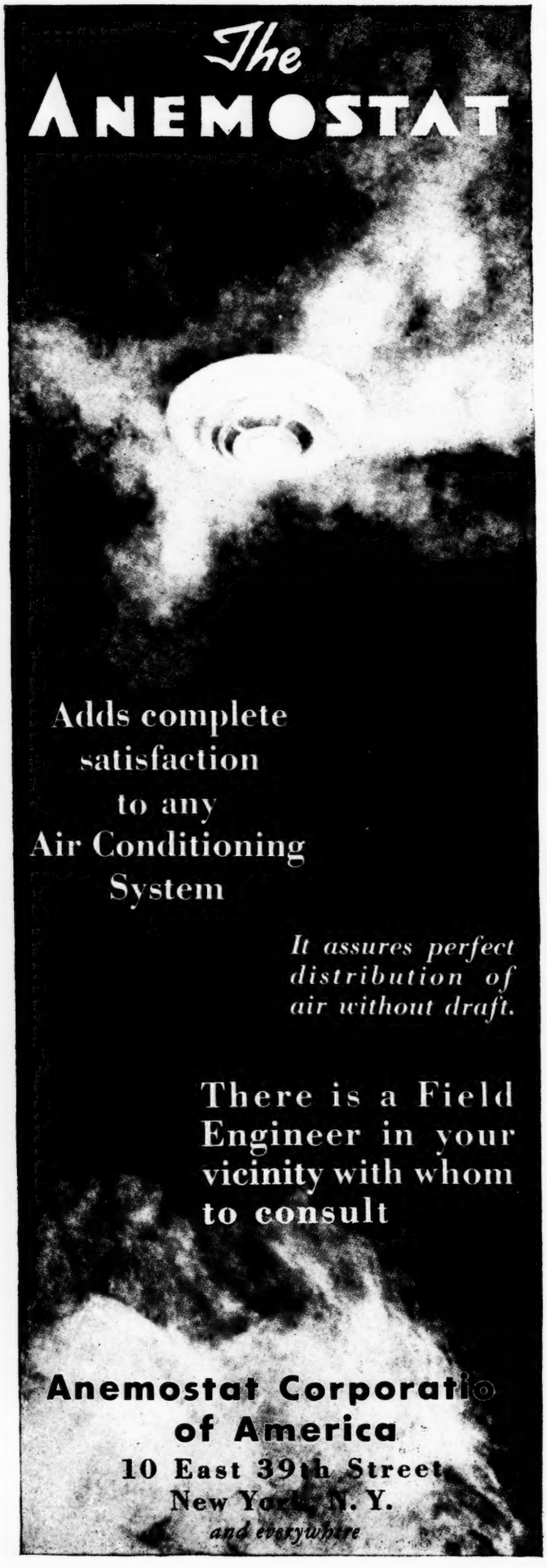
S-S-D is factory fabricated and packed in cartons for ease in handling, shipment and storage. Another feature is the time saved in erection.

Available for prompt shipment in any quantity, and in a complete range of sizes for domestic and industrial requirements. It is also furnished in flat sheets.

**Investigate this New Duct Material—**
**See Your Jobber or Write**

## SALL MOUNTAIN COMPANY

**176 W. Adams St., Dept. B-2, CHICAGO, ILL.**


The
ANEMOSTAT
Adds complete satisfaction to any Air Conditioning System
It assures perfect distribution of air without draft.
There is a Field Engineer in your vicinity with whom to consult
Anemostat Corporation of America
10 East 39th Street
New York, N. Y.
and everywhere

# PERSONALS AND PERSONNEL

### FRANK S. HECOX

secretary-treasurer and controller of the Iron Fireman Manufacturing Company, Portland, Ore., has been elected to membership in the Controllers Institute of America, a technical and professional organization of controllers devoted to improvement of controllership procedure.

### WADE MURPHY

for the past ten years assistant to Arnold Michaelson, vice-president of the Minneapolis-Honeywell Regulator Company in charge of the eastern zone, with headquarters in New York, is now special assistant to Thomas McDonald, vice-president of the new Minneapolis-Honeywell electronics plant at Chicago. Mr. Murphy joined Minneapolis-Honeywell in 1931.

### JOHN H. DOCKENDORFF

on leave from the T. A. D. Jones and Company, wholesale fuel oil marketers, New Haven, Conn., now heads the fuel oil section in the marketing division of the Office of Petroleum Coordinator. In his new position as fuel oil section chief, Mr. Dockendorff takes over the duties of Ned Foulds, who is devoting full time to industrial fuel oil conservation problems.

### H. P. BINDER

has been appointed manager of the Allis-Chalmers centrifugal pump department. Mr. Binder has been assistant manager of the hydraulic department, in charge of centrifugal pump sales and engineering, since 1940.

### BROWN INSTRUMENT CO.

announces that William J. Brown, New York zone sales-manager of the original equipment division of the Minneapolis-Honeywell Regulator Company, is now attached to the Brown Instrument Company division of Minneapolis-Honeywell and in charge of expediting materials in the New York area.

### RESEARCH PRODUCTS CORP.

Madison, Wisc., has appointed the following sales representatives: Haynes Selling Co., Inc., Philadelphia, Pa. (Eastern Pennsylvania, Delaware, Southern New Jersey); Gene O'Reilly Sales Co., Minneapolis, Minn. (Minnesota, North and South Dakota, northwestern Wisconsin); Colby Equipment Co., Indianapolis, Ind. (Central and southern Indiana); Guy W. Hale, Cleveland, Ohio (State of Ohio, Cleveland and adjacent territory).

### AVERY ENGINEERING COMPANY

Cleveland, has opened a branch office at 639 First-Central Tower, Akron, to cover the Akron-Canton area, with Robert E. Barnett as manager in charge. Another branch has been opened to serve the Dayton area under the direction of James M. Black, manager, at 533 Mutual Home Bldg., Dayton.

# WITH THE MANUFACTURERS

### KEWANEE BOILER CORP.

so as to clear the building entirely for military use, has changed the address of its New York office from 37 West 39th St., to Room 602, 40 West 40th St., New York. Phone Penn 6-4905. Manager H. W. McClure is in charge.

### B. F. STURTEVANT CO.

Hyde Park, Boston, Mass., has opened a new branch plant at LaSalle, Ill., to serve as the Company's mid-west production center, superseding the factory at Sturtevant, Wis., which has been closed. The new plant is 95 miles from Chicago, and is most advantageously situated to serve the mid-west area. It will be operated by J. F. Gibson as superintendent under the supervision of F. Herlan, general manager of the Company's mid-western division.

## INDUSTRIAL DEGREE DAYS OCTOBER, 1942

| City | Number of Industrial Degree Days | |
|---|---|---|
| | 55F Base | 45F Base |
| Baltimore | 26 | 3 |
| Buffalo | 110 | 18 |
| Chicago | 140 | 54 |
| Cleveland | 82 | 17 |
| Detroit | 112 | 27 |
| Indianapolis | 90 | 22 |
| New York | 30 | 3 |
| Philadelphia | 31 | 4 |
| Pittsburgh | 60 | 16 |
| St. Louis | 71 | 12 |

### FILTERS

**American Air Filter Co., Inc.**
**Louisville, Ky.**

A new 32-page, standard size bulletin, entitled "Air Filtration and Dust Control," analyzes and explains some of the theories covering atmospheric and industrial dusts, and the problems in connection with their elimination or control. Numerous laboratory and field installation photographs add to the interest of the new bulletin.

### ARC WELDING

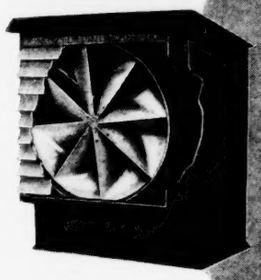
**General Electric Company**
**Schenectady, New York**

Bulletin GEA-2704 B, standard size, 32 pages, illustrates and describes company's line of welding accessories. Goggles, ventilated head protectors, ultra-violet ray protective paint, special clamps and the like, are discussed.


Recipe
FOR EFFECTIVE
BLACKOUT VENTILATION

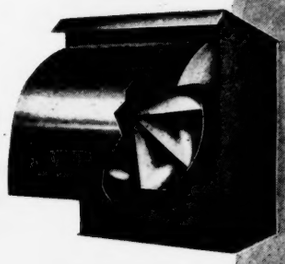
1 TAKE STANDARD MODEL ILG POWER ROOF VENTILATOR . . .

. . . complete with Ilg Self-Cooled Motor Propeller Fan in weather-tight, galvanized steel penthouse. Wide range of sizes and capacities. Positive and uniform in action, regardless of the weather or wind velocity.



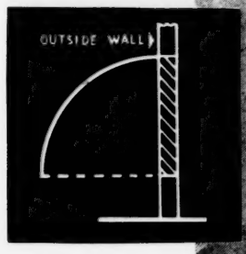
2 FABRICATE SHEET METAL BLACKOUT HOODS ON THE JOB . . .

. . . to positively prevent light transmission, without obstructing the air being exhausted. Ilg will supply contractors with complete drawings, dimensions and construction data for specific applications upon request.



3 ALSO BLACKOUT HOODS FOR FRESH AIR INLETS . . .

Blackout Hoods properly constructed on the job and positioned near the floor line according to data available from Ilg, run no danger of "short-circuiting" air circulation.




4 INSTALL ACCORDING TO ILG'S SPECIFICATIONS, DIMENSIONS and INSTRUCTIONS

If you are figuring on a specific job now, write, wire or phone for free dimension drawings and installation data.

FREE . . . *Blackout Bulletin*

Four-page, colorful bulletin, complete with drawings showing Ilg-engineered blackout ventilation installation in West Coast plant. Pictures complete line of Ilg apparatus used for blackout applications. Get it today!

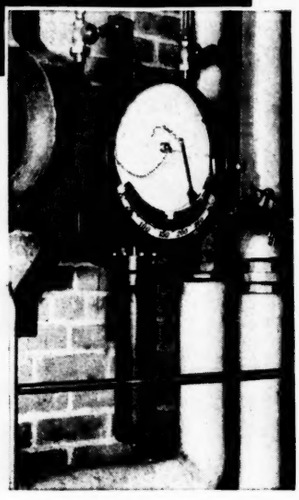
ILG ELECTRIC VENTILATING CO., 2858 N. CRAWFORD AVE., CHICAGO, ILL.
OFFICES IN 39 PRINCIPAL CITIES CONSULT YOUR PHONE DIRECTORY

ILG

VITALIZED VENTILATION
AND AIR CONDITIONING
AIR CHANGE . . . NOT JUST AIR MOVEMENT

LET THIS METER HELP

STRETCH YOUR STEAM



● The unprecedented demand for steam, coupled with the difficulty of obtaining new generating equipment, makes it essential to stop waste and squeeze every pound of steam from present generating equipment.

To do this most effectively, you need ADSCO Steam Flow Meters. They provide information that will enable you to

1. Establish the proper load distribution among boilers.
2. Center attention on the department or unit using excess amounts of steam.
3. Coordinate steam consumption with steam production.

In these ways, it may be possible to regulate your steam supply sufficiently to carry you through this critical period.

ADSCO Steam Flow Meters record and totalize on direct reading evenly divided charts, with exceptional accuracy at all rates of flow. They can be used for steam, water, compressed air or gas.

Write us regarding your meter problems—also, ask for Bulletin No. 35-83-V.

AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA N. Y.

MAKING "UP-TO-DATE" STEAMLINE EQUIPMENT FOR OVER 60 YEARS

LET ADSCO FLOW METER TELL YOU HOW MUCH . . . WHEN . . . WHERE


## SHEET METAL

**Young Radiator Company**
**Racine, Wis.**

A 4-page, standard size illustrated folder, Form No. 518, lists the numerous facilities which the company is offering for the manufacture of sheet-metal products. Included are spare parts and ammunition boxes, control boxes and covers, duct assemblies, military instrument holders, surge tanks, heavy-duty oil pans, and similar sheet-metal war products.

## PUMPS

**The Everite Pump & Manufacturing Co., Inc.**
**Lancaster, Pa.**

A new 4-page standard size bulletin illustrates and describes the Everite line of centrifugal jet and master turbine-type pumps for shallow and deep well applications and for all kinds of industrial uses. Operating principles, capacity tables and performance data are included.

## COMPRESSORS

**B. F. Sturtevant Company**
**Hyde Park, Boston, Mass.**

Catalog No. 386-2, standard size, 20 pages, printed in two colors, describes and illustrates the company's Design 9 line of centrifugal compressors. More than 200 sizes ranging in pressure from ½ to 3 pounds, and in volume up to 5500 cfm, are listed.

## PUMPS

**Deming Company**
**Salem, Ohio**

A new 68-page, standard size service manual just issued by the company is intended to fill a need for practical and readily available information on the servicing of pumps and water systems. Large sectional views of each type of pump have all the important parts identified clearly for quick reference. Other illustrations include close-up details of construction, line drawings, and full views of the various types of pumps.

## THREADING MACHINES

**Oster Mfg. Company**
**Cleveland, Ohio**

Catalog No. 43, standard size, 56 pages, printed in two colors, describes and illustrates the company's complete line of pipe and bolt threading machines. Portable types, as well as those designed for production, oil field and jobbing work, also devices for certain other special applications, are included.

## PUMPS

**Allis-Chalmers Mfg. Co.**
**Milwaukee, Wisconsin**

An 8-page bulletin B 6059-H lists construction features, sizes and capacities of single and double suction, single and multi-stage, mixed and axial flow, and other centrifugal pumps.

## CONTROLS

**Foxboro Company**
**Foxboro, Mass.**

New bulletin A-321 describes typical installations of Operation-Time recorders for various kinds of installations. Specifications are included for single and multiple-pen instruments.

### V-BELT DRIVES

**The Multiple V-Belt Drive Association**
**140 S. Dearborn St., Chicago, Ill.**

This 16-page, 8½ by 11 in. illustrated bulletin is the association's contribution to the rubber conservation movement. It has been prepared by the Engineering Research Bureau, and outlines the 23 principal means of prolonging belt life.

### BEARINGS

**SKF Industries, Inc.,**
**Front and Erie Avenues, Philadelphia, Pa.**

A 32-page, standard size lubrication manual entitled "A Guide to Better Bearing Lubrication." Discusses functions of lubrication, comparisons and applications of oil and grease lubrication, and high temperature, minimum friction and moisture protective applications.

### OIL BURNERS

**Hauck Manufacturing Co.**
**Brooklyn, N. Y.**

A new two-color, sixteen-page standard size catalog No. 407, illustrates and describes the company's proportioning oil burners. Sectional views illustrate working parts, and the bulletin also includes tables of burner capacities and dimensions.

### PIPE AND FLANGE BENDING

**A. M. Byers Company**
**Pittsburgh, Pa.**

A unique industrial training course for pipe fitters, plumbers, welders, and other metal workers, has been condensed into four, 8½ x 11 in. booklets and four large wall-type instruction charts. Both the booklets and the charts deal with the subjects of pipe threading, pipe bending, plate bending, and flame cutting and welding.

### MOTORS

**Allis-Chalmers Mfg. Co.,**
**Milwaukee, Wisconsin**

The company announces publication of a handbook entitled "A Guide to Wartime Care of Electric Motors." The book is intended as an up-to-date maintenance guide for war plant engineers. It contains no advertising.

### PIPING

**Fairbanks Company**
**New York, N. Y.**

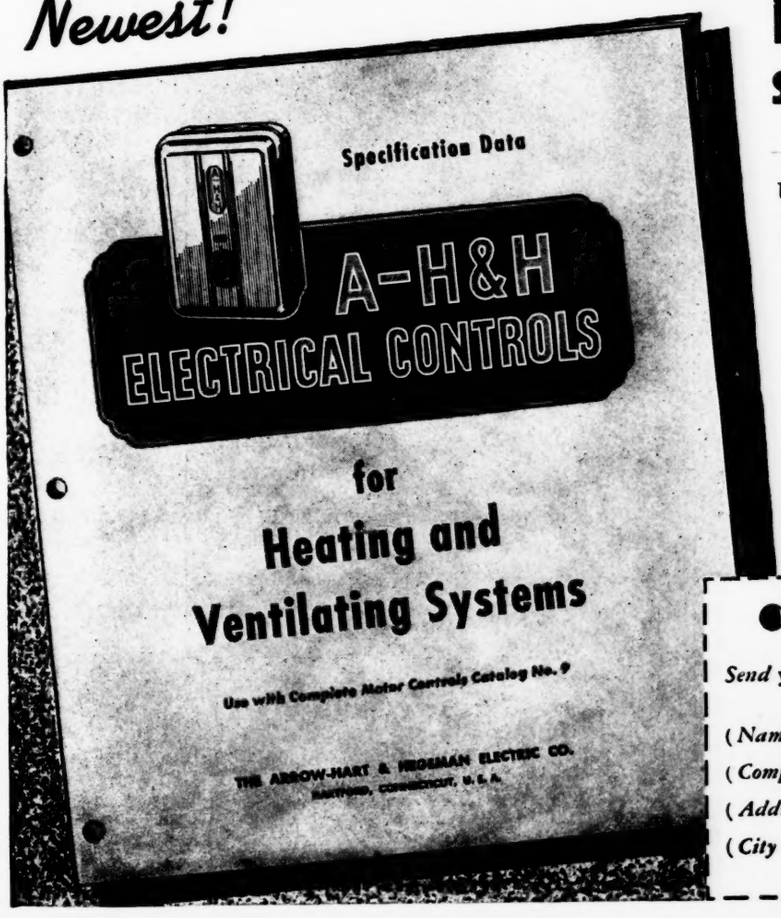
Catalog No. 42, size 7½ by 10½ in., contains 176 pages of descriptive matter with 250 illustrations covering Fairbanks bronze and iron valves and Dart unions. A number of worthwhile tables are included.

## COMING EVENTS

DECEMBER 12.—Annual Forum of The Technical Valuation Society, Engineering Societies Building. 33 West 39th St., New York. Further information from W. C. Fisher, Technical Valuation Society, 33 West 39th St., New York.

JANUARY 25-27.—49th annual meeting of the American Society of Heating and Ventilating Engineers, Hotel Gibson, Cincinnati, Ohio. Further information from A. V. Hutchinson, secretary, ASHVE, 51 Madison Ave., New York, N. Y.


*Newest!*




# ELECTRICAL
## SPECIFICATION DATA

— *for* the heating and ventilation Engineer. Up-to-the-minute information on what to specify for convenient, dependable control. Simplified arrangement of recommended Electrical Controls for each type of equipment in *your specialized field.* Will help you to get what you need now — *need urgently* — for eligible jobs. Use Coupon, save writing.

INDUSTRIAL CONTROL DIVISION,
ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN.

*To* Industrial Control Division, Arrow-Hart & Hegeman Electric Company, Hartford, Conn.

*Send* your new ELECTRICAL CONTROLS Data Book to

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(*Company*) _____

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(*City & State*) _____

HV

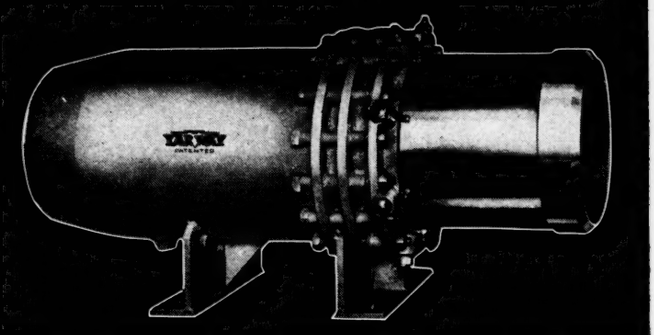
# YARWAY GUN-PAKT EXPANSION JOINT

It is packed under full steam pressure. By the turn of a wrench, integral pressure guns force a special semi-plastic packing into the stuffing box.

Welded Steel Construction. Alemite lubricated cylinder-guided sleeve. Made also in conventional gland-pakt types. Write for Bulletin EJ-1908.

•

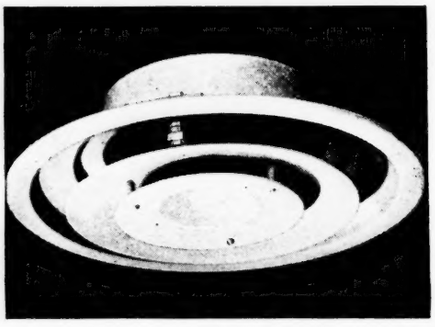
**YARNALL-WARING COMPANY**
104 Mermaid Ave. PHILADELPHIA



# KNO-DRAFT K-NEWS

## HOW TO DO A BETTER JOB FOR LESS!

The Kno-Draft* type W-A-R Air Diffuser points the way—redesigned to obtain even better performance while cutting the material in half—and passing on the savings in dollars too.



All of the Kno-Draft exclusive features are retained—draftless and noiseless uniform air diffusion—thorough air mixing—room temperature equalization—greater air volumes with lower resistance.
Also, **adjustability** to suit the season or the job.

**Formerly known as Dorex Kno-Draft Air Diffuser*

WB CONNOR ENGINEERING CORP

**W. B. CONNOR ENGINEERING CORP.**
114 East 32nd Street New York, N. Y.

# NOW! ACCURATE AIR VELOCITY MEASUREMENTS at INTAKE GRILLES!

This new jet attachment can be added to existing Tube-type Velometers now in use, or can be purchased with other standard jets and new Velometers. The new intake grille jet is offered only in the spot type since the center reading only has proven to be sufficiently accurate for all commercial purposes. *Write for information.*

*Illinois Testing Laboratories Inc.*
143 W. Hubbard St., CHICAGO, ILL.

# HEATING and VENTILATING'S REFERENCE SECTIONS

***Helpful information in concise form for the heating engineer and contractor. Price, 25c each.***

### FOOD DEHYDRATION

A progress report on the present status of a rapidly growing art insofar as it involves the air conditioning engineer. Includes basic information on principles and types of dryers and methods of calculating air, moisture and heat quantities and air velocities.

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Detailed information on the best methods for keeping electric motors in good operating condition.

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Practical information on design and construction of radiant heating systems, with examples of modern installations.

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How to design an underground steam system, with data for solution of problems and descriptions of typical installations.

### VENTILATION AND HEATING OF AIR RAID SHELTERS

Types of air raid shelter equipment necessary for adequate ventilation, with data for the design engineer.

Send your order with remittance to

**HEATING and VENTILATING**
148 Lafayette St., New York City

PICTURED here are some of the many applications to provide heat for industrial buildings and service camp structures where Dravo Heaters were installed, and, in many cases, in preference to a central steam heating plant.

Each Dravo direct fired heater is a self-contained unit with its own combustion chamber, motor and fans to circulate the warm air in the space to be heated. One or more of these heaters can be arranged to heat buildings of any shape.

Such a system is quickly installed, furnishes instant heat and represents a substantial saving in manhours and scarce metals over a central steam heating plant and necessary distributing system.

Types for any application—models for all fuels—request Bulletin 505—or consult "Sweets."

**DRAVO CORPORATION**

*Heater Department*

**DRAVO BLDG., PITTSBURGH, PA.**

Forty-seven Sales Offices in Principal Cities


HEATING AND VENTILATING, *formerly*, HEATING & VENTILATING MAGAZINE, published monthly by THE INDUSTRIAL PRESS, 148 Lafayette Street, New York, N. Y., U.S.A. Subscription rates: United States and Canada, $2.00; Foreign, $3.00. Single copies, 30 cents. Vol. 39, No. 12, December, 1942. Entered as second-class matter, April 18, 1925, at the Post Office at New York, N. Y., under the act of March 3, 1879.

# NOTHING MATTERS RIGHT NOW but winning the war *because* Nothing Will Matter if we don't win it

© Oliver J. Prentice

Of course we'll win — but how soon? — That rests with hundreds of thousands of Americans who *yet* feel that somehow, someway, this war will come to a conclusion without involving them more than Bond buying, Rubber saving, Food rationing or U S O contributions.

But no magic will end this war. And lip service won't end it — and tanks, planes, guns — your boy in the service won't end it. *You* and I — we, the people who continue in business, who still continue to live almost as usual, — we will end it when we adjust our lives to the sole purpose of winning.

Do you require price ceilings to keep you from buying and boosting the cause of inflation? Do you believe in tightening your belt, curtailing your traveling, cutting waste in materials, fuels, foods that load freight facilities when every freight car is needed for War goods and War needs?

Do you believe in America? So do we! Then let's quit talking. Let's you and I start to find ways to throw our own personal weight into this war. Let's show the axis what happens when *all* of America goes all out for Victory.

*Dunham Makes Fuel Go Further*

*"Dunham Heating Service" is available through the telephone in more than 60 cities, or by correspondence to C. A. Dunham Co., 450 E. Ohio St., Chicago.*

The DUNHAM HEATING SERVICE

**THIS IS APPROXIMATELY** how a Jap plane would appear, if you were looking through the telescopic sight of the director which computes the gun positioning data of an anti-aircraft battery.

# Memo to maintenance engineers about dust

THE ACCURACY of a gun sight can make all the difference between a dead Jap pilot and a Jap bomb hit.

That such gun sights are accurate depends on superb design, materials, assembly, engineering skill, and the dust-free rooms in which such gun sights are made.

**Helping keep air dust-free in one factory where gun sights are made is the job of Fiberglas* Dust-Stop* Air Filters.**

This use dramatizes how important dust-free air has become in war industries and is indirectly a reminder to maintenance engineers in charge of air-conditioning systems about the importance of replacing filters on schedule.

Most automatic telephone exchanges operate with a minimum of wrong numbers and no static during conversation partly because this intricate mechanism works in air filtered by Dust-Stops.

In paint spray booths, where whole 4-engine bombers are spray painted after assembly, workmen are shielded from noxious fumes and the explosion hazard is greatly reduced by circulating a large volume of Dust-Stop filtered air.

*Dust-Stops remove process dusts in grinding operations from factory air; in shell loading and powder plants Dust-Stops contribute to cleanliness and safety.*

In scores of war industries, Dust-Stops are doing yeoman service in connection with air conditioning and ventilating systems. Maintenance men are keeping their systems near top operating condition at low cost by vacuum cleaning filter intake faces or by rapping out heavy dust accumulations. They also find Dust-Stops easy to change, requiring no special tools or skills. Replacements are made quickly without hindrance to continuous operation.

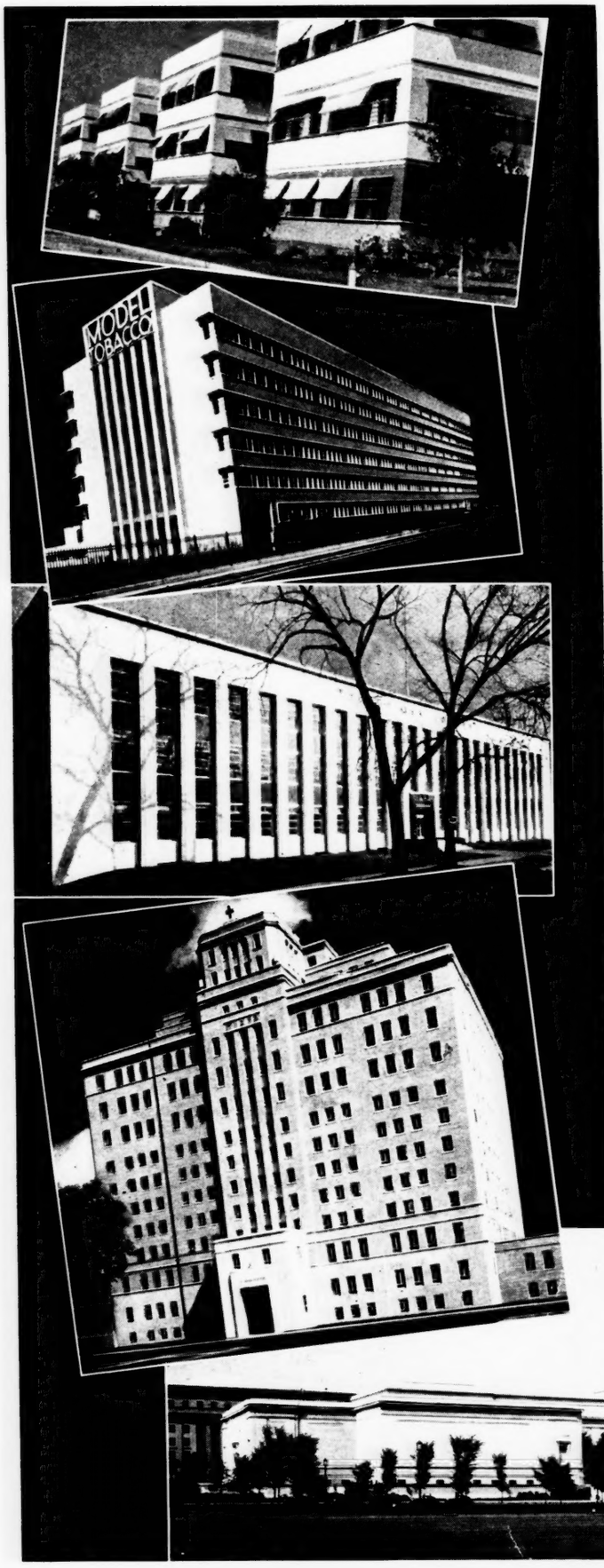
If your regular supplier cannot give you costs and maintenance data on Dust-Stops, write us. *Owens-Corning Fiberglas Corporation, Toledo, Ohio. In Canada, Fiberglas Canada, Ltd., Oshawa, Ontario.*

**FIBERGLAS***

**DUSTOP***

**AIR FILTERS**

*T. M. Reg. U. S. Pat. Off.




*Where*

# PERFORMANCE

*and*

# APPEARANCE

***were the determining factors, you will find***

**uni-flo** GRILLES and REGISTERS

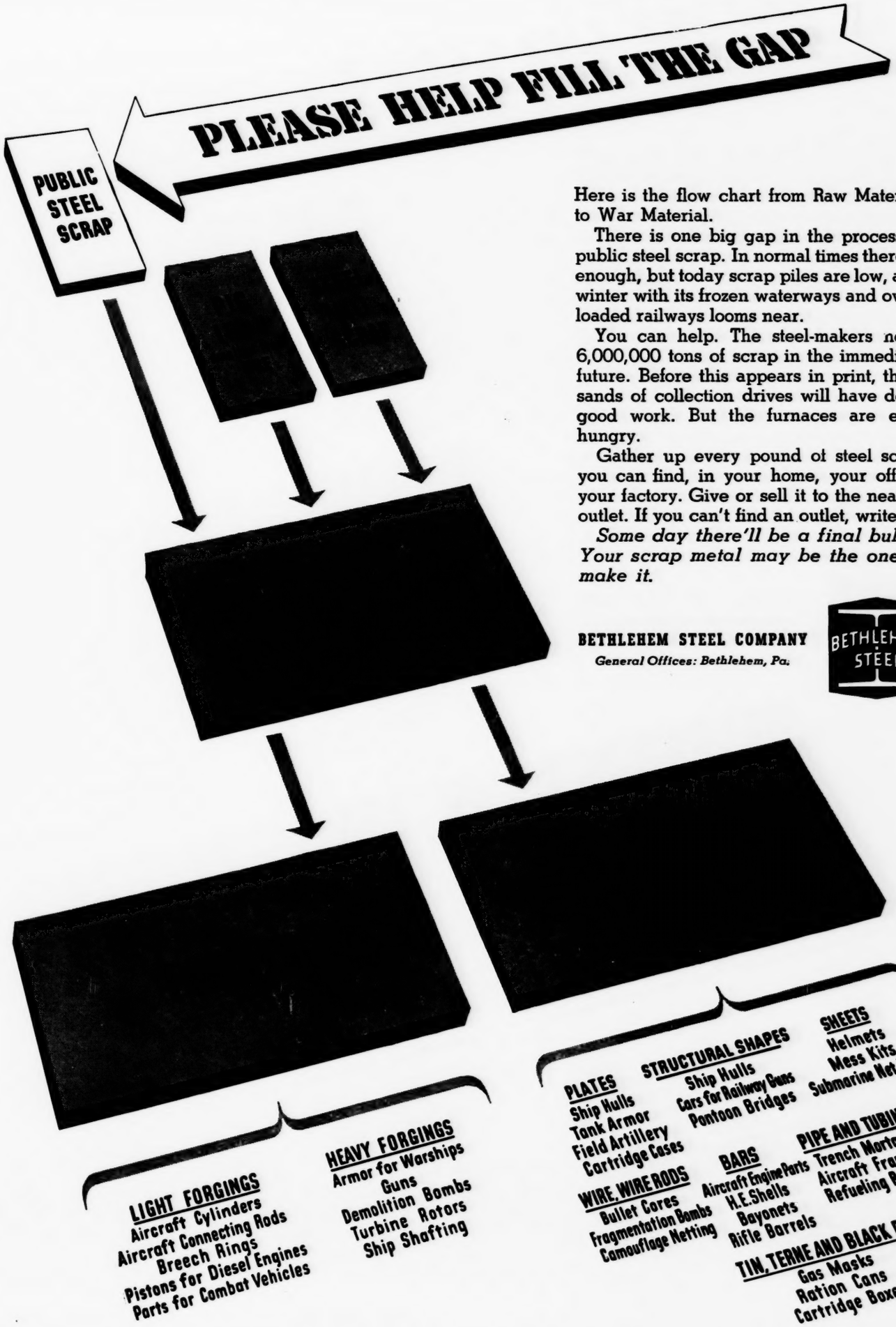
*and*

**venturi-flo** AIR DIFFUSERS

The buildings shown here are selected from the many in which UNI-FLO and VENTURI-FLO equipment is installed, chiefly because they are outstanding examples of careful design and construction in every detail. The Grilles, Registers, and Air Diffusers used in these buildings were picked for their proven performance and satisfying appearance. UNI-FLO Grilles and Registers and VENTURI-FLO Air Diffusers give *guaranteed* performance because selection of individual units is based on reliable engineering data obtained from exhaustive laboratory and field tests. Take advantage of this unique and soundly scientific method of selection, and you can be assured that UNI-FLO and VENTURI-FLO products will provide uniform, complete, draftless, and *guaranteed* air distribution.

*See our Catalog in Sweet's*

**BARBER-COLMAN COMPANY** 1224 ROCK STREET ROCKFORD, ILLINOIS




Here is the flow chart from Raw Material to War Material.

There is one big gap in the process—public steel scrap. In normal times there is enough, but today scrap piles are low, and winter with its frozen waterways and overloaded railways looms near.

You can help. The steel-makers need 6,000,000 tons of scrap in the immediate future. Before this appears in print, thousands of collection drives will have done good work. But the furnaces are ever hungry.

Gather up every pound of steel scrap you can find, in your home, your office, your factory. Give or sell it to the nearest outlet. If you can't find an outlet, write us.

*Some day there'll be a final bullet. Your scrap metal may be the one to make it.*

**BETHLEHEM STEEL COMPANY**
*General Offices: Bethlehem, Pa.*

BETHLEHEM STEEL

# AAF Filters protect them from dust

Dust is a major problem both in the manufacture and maintenance of our great air armada. The important part which dust control plays in manufacture was soon discovered by airplane builders who turned to AAF engineers early in the war emergency to solve their dust problems.

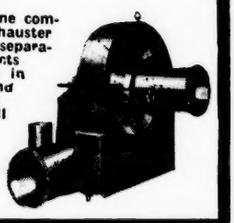
Following manufacture came maintenance, which due to make-shift airport facilities necessary in combat zones, again found dust a serious hazard. Engine performance records in Libya, Australia and elsewhere, made under actual fighting conditions, show that motors not protected by air filters, require overhauling and rebuilding after only 20 to 30 hours, due to the severe dust conditions. With AAF airplane engine filters, which remove 90% to 99% of the dust which causes this excessive wear, the overhaul period can be increased to 300 or 400 hours, thus saving valuable replacement parts and reducing oil and gas consumption.

So—on the line—in production and in combat AAF filters protect our war planes.

If you are confronted with a dust problem in your business—write us —we can help you too!

**AAF** airplane engine filters protect our fighting planes against destruction by dust.

**AAF** atmospheric dust control equipment is installed in every major airplane factory in the U. S. A.



Roto-Clone combined exhauster and dust separator protects materials in process and personnel against all forms of process dust.

AMERICAN AAF AIR FILTERS

**AMERICAN AIR FILTER COMPANY, INC. 294 CENTRAL AVE, LOUISVILLE, KY.**
INCORPORATED

IN CANADA, DARLING BROTHERS, LIMITED, MONTREAL, P. Q.

# WeldELLS

## WeldELLS have everything—

No other fittings for pipe welding combine the features found in WeldELL. In addition to that described, they include:

▶ **Seamless**—greater strength and uniformity.

▶ **Tangents**—keep weld away from zone of highest stress—simplify lining up.

▶ **Precision quarter-marked end**—simplify layout and help insure accuracy.

▶ **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.

▶ **Wall thickness never less than specification minimum**—assures full strength and long life.

▶ **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.

▶ **The most complete line of Welding Fittings and Forged Steel Flanges in the world**—insures complete service and undivided responsibility.

## It's the difference between RIGHT and WRONG —*this "selective" reinforcement*

BOTH mathematical calculations and practical tests* prove that the bursting stresses in an elbow are greatest at the crotch or inner wall. That's why a special process is employed in producing WeldELLS which provides extra metal in this region of greatest stress as pointed out above. It is the nearest possible approach to the "One Hoss Shay" ideal of absolutely uniform strength throughout.

And it's also one more example of the length to which we have gone in producing WeldELLS to follow sound engineering considerations—considerations which mark the difference between right and nearly right.

An extra value, this—and opposite are listed other extra-value features that are combined in no other fittings for pipe welding. Yet: WeldELLS cost no more!

* The amount by which stress is greater at the crotch in a fitting having uniform wall thickness depends only on its radius. Mathematical analysis (specifically the Lorenz formula) shows the stress at the crotch to be:

$$S = \frac{pr\,(2R - r)}{2t\,(R - r)}$$

Where S = Bursting stress, lbs. per sq. in.
p = Internal pressure, lbs. per sq. in.
r = ½ inside diameter of fitting (O.D. if Barlow's formula is desired).
t = Wall thickness in inches.
R = Center line radius of fitting, inches.

Numerous tests by the Research Division of Taylor Forge show the formula given above to be somewhat on the conservative side.

**TAYLOR FORGE & PIPE WORKS,** General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

# STREAMLINE YOUR STEAM LINES..WITH *ALL-WELDED* INSULATED PIPE UNITS

Welding Connections between flanged units

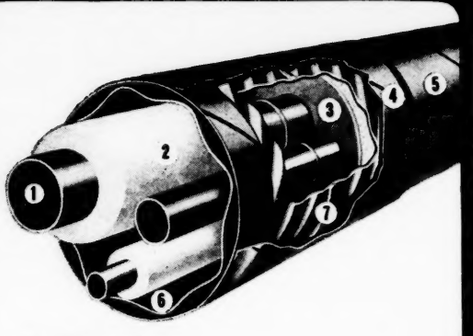
## . . For Faster Steam Supply!

**SPEED on installation of steam lines is of utmost importance in wartime construction. Ric-wiL does most of the work in the factory—so *you* don't have to do it on the job. That saves precious time! And a Ric-wiL job is complete—you don't wait for missing parts or for a great variety of labor in the field!**

**For a steam-and-watertight connection on both pipe and conduit, use Ric-wiL Insulated Pipe Units with *all-welded* connections, as pictured above. They give a perfect, permanent seal and a joint of maximum strength.**

**These are totally pre-fabricated, ready-to-install units, ideal for both speed and economy. Structural strength of Hel-Cor spiral conduit exceeds *any normal* service requirements. Units are furnished in 20-foot lengths, for single and multiple pipes, for any kind of steam pipe or insulation desired, for underground or overhead. Can be quickly installed, with minimum trenching, in ANY kind of weather. All expansion loops, conduit fittings, anchors, watertight glands for walls, and other parts can also be furnished ready to install.**

**Write for Catalog "S", showing *all* types of Ric-wiL Conduit construction.**




**1—Steam pipe**
**2—Sectional pipe covering**
**3—Pipe support**
**4—Thick strip asphalt applied after welding**
**5—Asbestos felt over asphalt coated Hel-Cor**
**6—Air space**
**7—Butt welded connection**

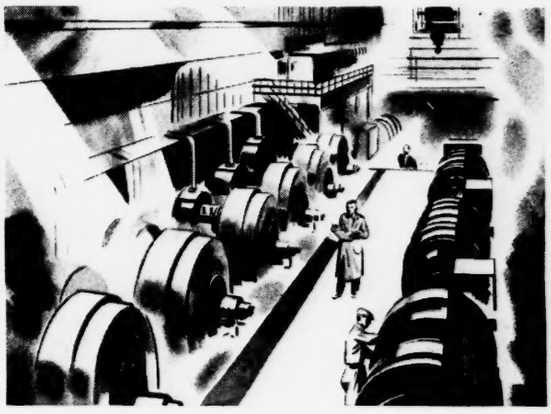
**Engineers on War Projects ONLY: Ask on your letterhead for Engineering Manual 420-A.**

**RIC-WIL** CONDUIT SYSTEMS FOR UNDERGROUND STEAM
THE RIC-WIL COMPANY · CLEVELAND, OHIO
AGENTS IN PRINCIPAL CITIES

# PRECIPITRON* CLEANS THE AIR FOR AMERICAN WAR INDUSTRIES

## 90% of All Particles as Small as 1/250,000 of an Inch Cleared Away by ELECTRIC AIR CLEANING

By removing tiny, air-borne abrasive and corrosive particles, Precipitron is protecting superfinished surfaces of airplane engine parts and other materiel.



To reduce the threat of maintenance shutdowns in steel mills and central stations, Precipitron cleans the ventilating air for large rotating electrical machinery.

Where industrial operations create excessive amounts of harmful smoke, fumes and oil vapors, electric air cleaning clears the air and reduces ventilating costs.

In pharmaceutical laboratories where miasma-free conditions are essential, Precipitron's "total air cleaning" removes one of the major dangers of atmospheric contamination.

Because it removes particles as small as 1/250,000 of an inch, electric air cleaning reduces the number of rejects in the manufacture of delicate optic systems.

### SEND FOR THIS FOLDER

For a full story of electric air cleaning's war production applications, write for the new Precipitron folder, B-3083.

*Trade-mark registered in U. S. A.

**Westinghouse**

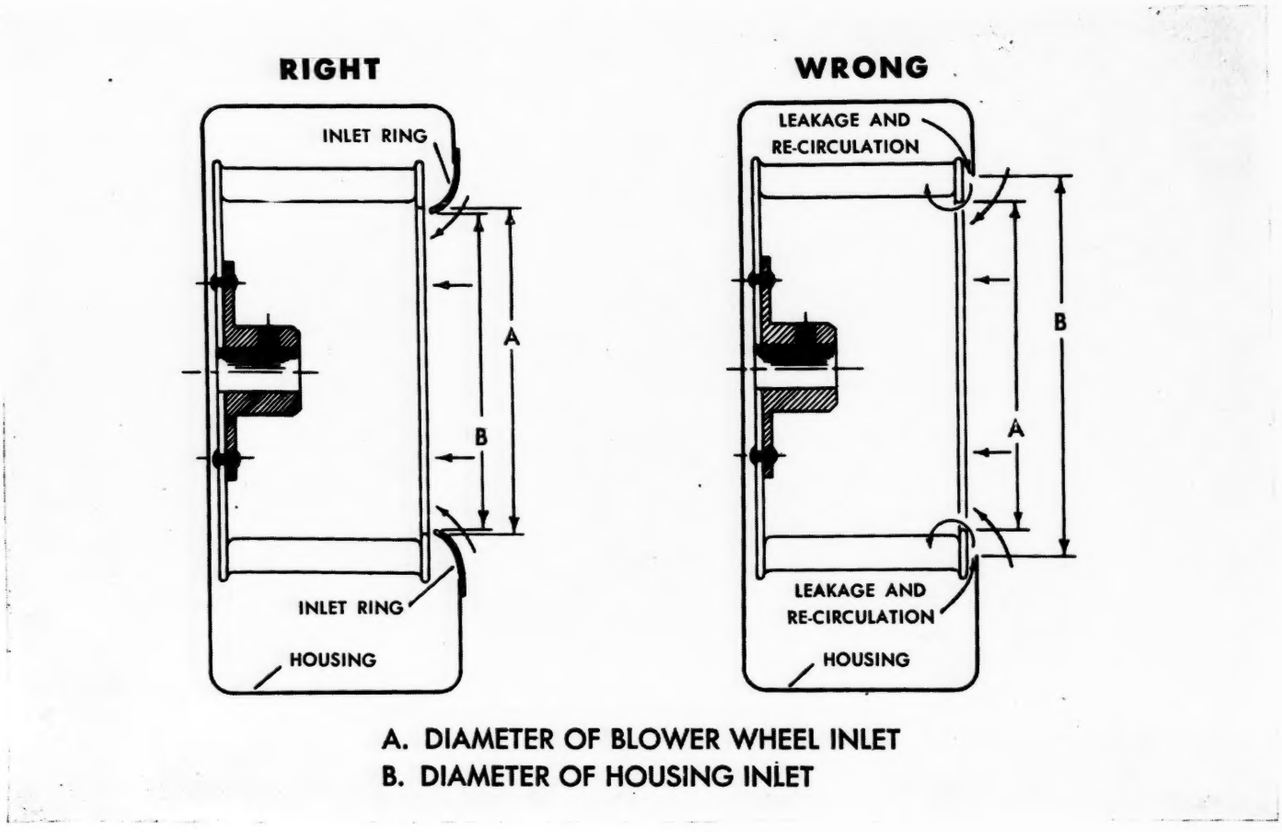
EDGEWATER PARK • CLEVELAND, OHIO

WESTINGHOUSE

*Precipitron*

# Tips for Designing Air Impelling Units

*No. 2 of a series*




A. DIAMETER OF BLOWER WHEEL INLET
B. DIAMETER OF HOUSING INLET

## *The Diameter of the Housing Inlet should not exceed the Diameter of the Blower Wheel Inlet*

EXPERIENCE shows that a ratio of .95 of the housing inlet diameter to the diameter of the blower wheel inlet is best for efficient performance, except in the case of high pressure wheels, which require less air and where this ratio may therefore be less. However, in no instance should the diameter of the housing inlet exceed that of the blower wheel inlet, or loss of air pressure will result (*see diagram*).

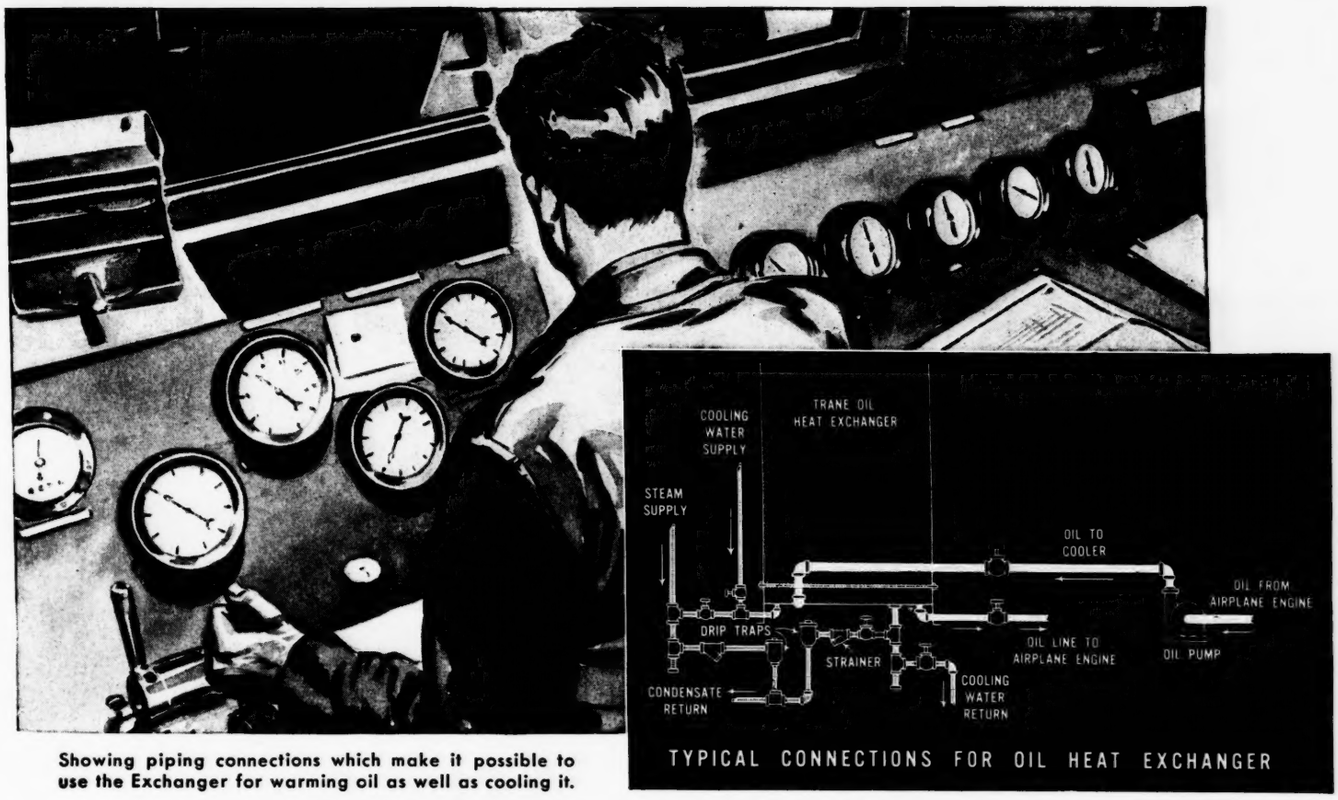
The function of the housing inlet ring is to facilitate the flow of air into the blower wheel and to prevent leakage or re-circulation at this point, thereby helping to maintain the desired pressure.

Therefore, the inlet ring should never be omitted, even where installation of the wheel must be made through the housing inlet. Where the wheel is not installed through the housing inlet, the inlet ring may be formed in the side plate, but care should be taken that the ratio of .95 is maintained.

This important rule of blower design is but one of many that affect the performance of air impelling units. Manufacturers of any product requiring the movement of air are invited to consult Torrington's Research Laboratory, preferably during the early design stages. No obligation, of course.

THE TORRINGTON
MANUFACTURING COMPANY, TORRINGTON, CONN.

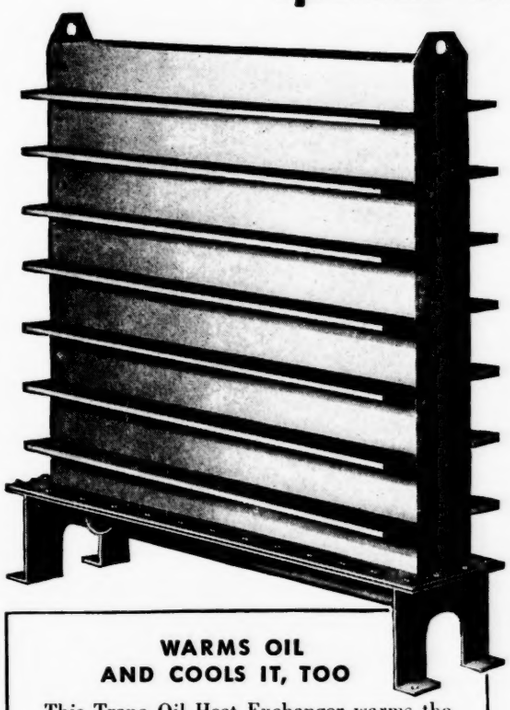
**MANUFACTURERS OF AIRISTOCRAT QUIET PROPELLER FAN BLADES & AIROTOR BLOWER WHEELS**




**Showing piping connections which make it possible to use the Exchanger for warming oil as well as cooling it.**

# NEW TRANE OIL HEAT EXCHANGER

## *speeds aircraft engine testing*



**WARMS OIL AND COOLS IT, TOO**

This Trane Oil Heat Exchanger warms the oil with steam, cools it with water. Externally ribbed to enable the flat surfaces to withstand the necessary pressure without excessive weight. This represents another of the many problems solved through the use of Trane heat transfer equipment of both standard and special design.

AN IMPORTANT producer of airplane engines needed a combination unit to control oil temperature of engines on test. During the starting-up period, the unit was required to deliver warm oil to the engine, and during the running period the unit was required to hold the temperature below a certain limit.

Specifications called for a light, compact, durable heat exchanger that would be easy to mount and take down for cleaning. It had to have a casing that would withstand 30 pounds oil pressure, and, finally, only a limited amount of cooling water could be used.

The Oil Heat Exchanger illustrated here was designed by Trane engineers to fill the requirements. Going a step beyond the letter of the specifications, Trane engineers produced a unit that could be thoroughly cleaned without disconnecting any of the heating, cooling, or oil line piping.

### Ask the Trane Man

The facilities of the Trane design engineering department are at the disposal of government and industry in the design of new and refined equipment to meet the many demands created by a nation at war. Because standard Trane heating, cooling, drying, air handling and related products are used in so many fields of industry, Trane engineers have a thorough knowledge of the equipment requirements of industry. Your nearby Trane field office will be glad to furnish additional details.

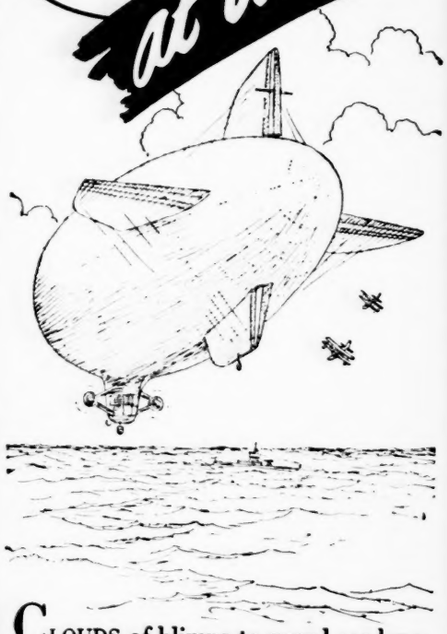
# THE TRANE COMPANY

**LA CROSSE, WISCONSIN**

**Also TRANE COMPANY OF CANADA LTD., TORONTO, ONTARIO**

**HEATING • COOLING • AIR CONDITIONING EQUIPMENT FROM 85 OFFICES**

# STEAM Heats America—at war!



CLOUDS of blimps to guard sea lanes.

To make it too "hot" for Axis U-boats.

It's the goal of American Industry to produce more blimps than the world has ever seen—and that goal is going to be achieved.

It calls for construction and conversion at record-breaking speeds to get into production as soon as possible.

In every war plant, proper heating is essential to maximum output.

Fifty years of experience taught America all of the natural advantages of steam—speed, safety, flexibility and economy.

Webster Systems of Steam Heating have proved their effectiveness in more than 75,000 buildings. The engineering skill that makes Webster Equipment effective is offered to architects, engineers and heating contractors working on war construction.

Today, we are engaged in direct war work, but manufacturing facilities are still available to supply Webster Steam Heating Equipment for buildings serving the war effort.

Essential repairs for Webster Systems are available on A-10 priority, under W. P. B. Emergency Repair Order P-84. Orders should be limited to actual needs.

Warren Webster & Company, Camden, N. J.
Representatives in 60 principal Cities

Webster
Steam Heating

This is one of a series of advertisements that tells the public of the part that Webster Steam Heating and the Webster organization plays in the war effort . . . appearing regularly in leading business, industrial, engineering and technical publications.

J. E. Hutchison, of Moody & Hutchison, Consulting Engineers, Philadelphia. Member of American Society of Heating and Ventilating Engineers.

"The wisdom of providing adequate control of volume and distribution of heat is being proved today as the fuel situation becomes more critical," says J. E. Hutchison. "The present users of modern steam heating system controls are enjoying even temperatures with minimum fuel consumption. Irrespective of the fuel or firing method adopted, satisfactory heating results cannot be obtained without effective volume and distribution control. Without this control, heating is uneven and fuel consumption excessive."

Moody & Hutchison have specified the "Controlled-by-the-Weather" Webster Moderator System of Steam Heating for Cooper Hospital, Camden, N.J., and for the Academic Building and Cadet Barracks, U. S. Military Academy, West Point, N. Y. In the latter installation, eight heating zones are controlled from one central point. This firm made plans for Webster Vacuum Steam Heating Systems installed in many outstanding buildings, including the Municipal Court Building, Philadelphia; the Federal Reserve Board Building and Folger Library, both in Washington, D. C.; Bancroft Hall, U. S. Naval Academy, Annapolis, Md.

## WARREN WEBSTER & COMPANY

CAMDEN, N. J., EST. 1888, PIONEERS OF VACUUM STEAM HEATING

## A leading aircraft company needs engineers, architects, draftsmen, designers and other technicians . . . and at once

A LONG ESTABLISHED major aircraft company in Maryland has positions immediately available in the Engineering Department which can be filled by engineers who have *not* had previous aircraft experience or training.

STRUCTURAL, CIVIL, MECHANICAL, AND ELECTRICAL ENGINEERS AND DRAFTSMEN, ARCHITECTS, MACHINE DESIGNERS, ETC., if properly qualified, can be satisfactorily fitted into certain positions in our Drafting, Stress Analysis, and Weights Department.

Our minimum requirements for consideration for these positions are: high school education (college preferred); age range 28 to 50; five years of actual engineering or drafting experience; American citizens only. Those now employed at their highest skills in war work not considered.

Our present Engineering Department is not large. The opportunities for varied aircraft experience and advancement are great.

Replies should include full details of experience, education, and other background; must include a small non-returnable photograph, and should be addressed to: Box 558, HEATING AND VENTILATING, 148 Lafayette St., New York.

**DE-STA-CO**

**Blower Wheel Housings**

*of Standard Dimensions*

Made in sizes to fit 4½, 5, 6, 7½ and 9 inch wheels and in widths to suit single or double inlet wheels . . . also individual parts for your own assembly.

De-Sta-Co housings are engineered for maximum efficiency and quietness in operation . . . neatly finished. Send for "De-Sta-Co Blower Housings" bulletin; gives complete information, including essential dimensions.

**DETROIT STAMPING CO.**

*Established Over 25 Years*

375 Midland Ave • Detroit, Mich.



**POWERS**

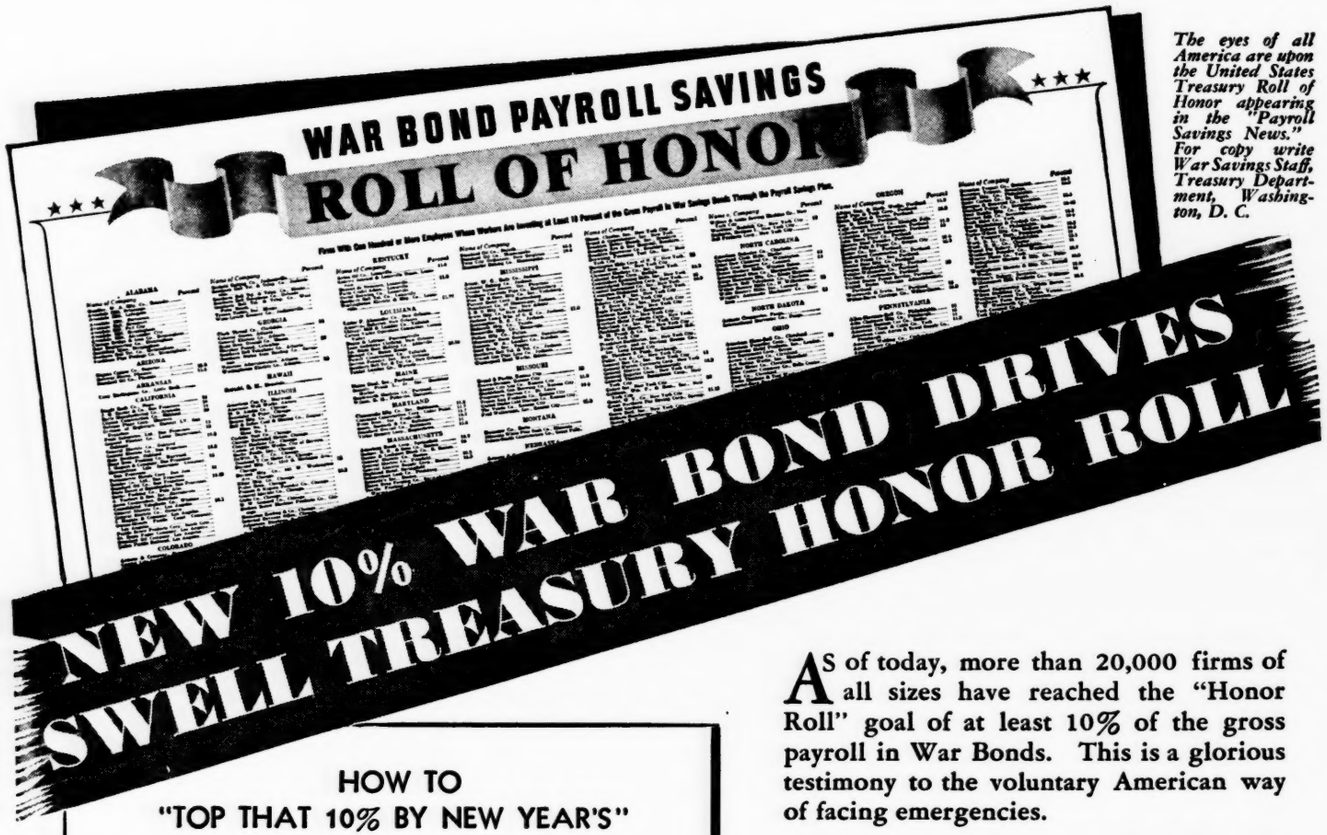
INDICATING and RECORDING THERMOMETERS

Some of the many different types of Dial Indicating and Recording Thermometers we make are shown here. We also make Recording Regulators and Regulators combined with easy to read Indicating Thermometers. **Write for Bulletins.** Specify type of instrument in which you are interested.

THE POWERS REGULATOR CO.
2718 Greenview Avenue, CHICAGO

*Offices in 47 Cities—See your phone directory*

**50 Years** of Temperature and ★ Humidity Control ★




*The eyes of all America are upon the United States Treasury Roll of Honor appearing in the "Payroll Savings News." For copy write War Savings Staff, Treasury Department, Washington, D. C.*

## HOW TO "TOP THAT 10% BY NEW YEAR'S"

Out of the 13 labor-management conferences sponsored by the National Committee for Payroll Savings and conducted by the Treasury Department throughout the Nation has come this formula for reaching the 10% of gross payroll War Bond objective:

1. ***Decide to get 10%.***
   It has been the Treasury experience wherever management and labor have gotten together and decided the job could be done, the job was done.
2. ***Get a committee of labor and management to work out details for solicitation.***
   a. They, in turn, will appoint captain-leaders or chairmen who will be responsible for actual solicitation of no more than 10 workers.
   b. A card should be prepared for each and every worker with his name on it.
   c. An estimate should be made of the possible amount each worker can set aside so that an "over-all" of 10% is achieved. Some may not be able to set aside 10%, others can save more.
3. ***Set aside a date to start the drive.***
4. ***There should be little or no time between the announcement of the drive and the drive itself.***
   The drive should last not over 1 week.
5. The opening of the drive may be through a talk, a rally, or just a plain announcement in each department.
6. Schedule competition between departments; show progress charts daily.
7. Set as a goal the Treasury flag with a "T."

AS of today, more than 20,000 firms of all sizes have reached the "Honor Roll" goal of at least 10% of the gross payroll in War Bonds. This is a glorious testimony to the voluntary American way of facing emergencies.

But there is still more to be done. By January 1st, 1943, the Treasury hopes to raise participation from the present total of around 20,000,000 employees investing an average of 8% of earnings to over 30,000,000 investing an average of at least 10% of earnings in War Bonds.

You are urged to set your own sights accordingly and to do all in your power to start the new year on the Roll of Honor, to give War Bonds for bonuses, and to purchase up to the limit, both personally and as a company, of Series F and G Bonds. (Remember that the new limitation of purchases of F and G Bonds in any one calendar year has been increased from $50,000 to $100,000.)

*TIME IS SHORT.* Our country is counting on you to—

## "TOP THAT 10% BY NEW YEAR'S"

EVERYBODY EVERY PAYDAY AT LEAST 10%

*Save with*
# War Savings Bonds

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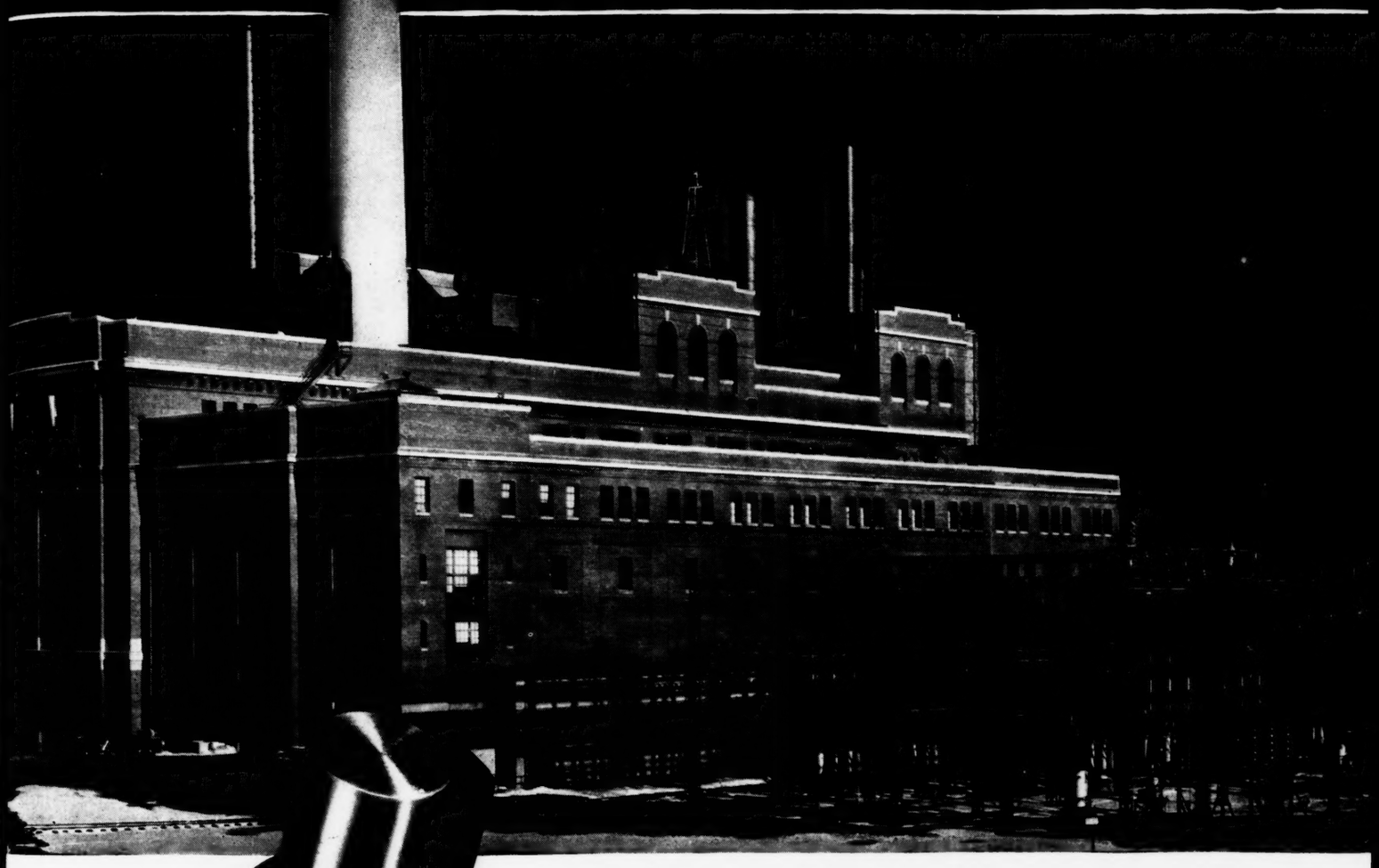
## *At Hartford Electric*



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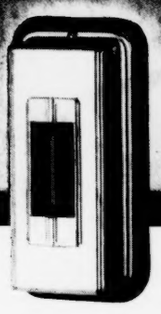

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